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Implementing Embedded Training (ET): Volume 4 of 10: Identifying ET Requirements

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Manned Systems Group
Systems Research Laboratory

U.S. Army Research Institute for the Behavioral and Social Sciences

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A procedure for developing Embedded Training (ET) Requirements (ETRs) is presented. The procedure consists of four phases: The first two are directly analogous to task identification and task analysis as normally performed in Instructional Systems Development (ISD) Front-End Analysis (FEA). The third phase nominates identified tasks and behavioral performance objectives for ET, based on their properties of criticality to successful mission accomplishment and perishability without periodic reinforced practice. Then, the nominated tasks and objectives are assessed for feasibility of implementation and for approaches that may later be adopted in an ET component designed to meet the identified ETRs. The fourth phase consists of preparing documentation for the identified ETRs. Techniques for computer database management to support the analysis process, and other tools helpful for analysis, are presented in three Appendixes.

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Human Performance Effectiveness and Simulation

This document is the fourth in a series produced by the Army Research Institute for the Behavioral and Social Sciences (ARI) and the Project Manager for Training Devices (PM TRADE). The series consists of 10 related documents that present guidance for combat and training systems developers, including Army Materiel Command (AMC) laboratories, Training and Doctrine Command (TRADOC) Combat Developers and Training Developers, and contractor organizations involved in system development or developing technological thrust areas under independent research and development (IR&D) programs.

This series of documents includes guidelines and procedures that support the effective consideration, definition, development, and integration of embedded training (ET) capabilities for existing and developmental systems. The documents share the general title of Implementing Embedded Training (ET), with specific, descriptive subtitles for each document. They are as follows:

1. Volume 1: Overview presents an overall view of the guidance documents and their contents, purposes, and applications, including a discussion of the following:

   a. what the total training system concept, including embedded training, is;

   b. how training systems must develop within more general processes of materiel system development;

   c. how embedded training must affect this relationship; and

   d. what the content and uses of the remaining documents in the series are, as well as their relationships to the training systems development and acquisition processes, and how to use them.

2. Volume 2: ET as a System Alternative provides guidelines for the initial decision on whether ET should be further considered as a training system alternative for a given materiel system. It also includes guidance on considering ET as an alternative for systems under product improvement or modification, after fielding.

3. Volume 3: The Role of ET in the Training System Concept contains guidance for the early estimation of training system requirements and the potential allocation of such requirements to ET.

4. Volume 4: Identifying ET Requirements presents procedures for defining ET requirements (ETRs) at both initial levels (i.e., before initiating system development) and for revising and updating initial ETRs during system design and development.

5. Volume 5: Designing the ET Component contains analytic procedures and guidance for designing an ET component concept for a materiel system, based on specified ETRs.

6. Volume 6: Integrating ET with the Prime System discusses considerations, guidance, and "lessons learned" about factors that influence the effective integration of ET into materiel systems.

7. Volume 7: ET Test and Evaluation presents guidance for defining the aspects of the ET component (test issues) to be addressed in prototype and full-scale system testing.

8. Volume 8: Incorporating ET into Unit Training gives guidance for integrating ET considerations and information into unit training documentation and practice.

9. Volume 9: Logistics Implications presents helpful information on key logistics issues that should be addressed in the context of ET integration with prime item systems.

10. Volume 10: Integrating ET into Acquisition Documentation discusses developing the necessary documentation for, and specification of, an ET Component of a prime item during the Army's systems development and acquisition process. This document examines the Life Cycle System Management Model (LCSMM) and the Army Streamlined Acquisition Process (ASAP) and describes where and how to include ET considerations in the associated documentation. It also describes how to use the other volumes in the ET Guidelines series to generate the information required for the acquisition documentation, and provides guidance in preparing a contract Statement of Work for an ET Component to a prime item system.

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IMPLEMENTING EMBEDDED TRAINING (ET):
VOLUME 4 OF 10: IDENTIFYING ET REQUIREMENTS

CONTENTS

CONTENTS (Continued)

Page

LIST OF FIGURES

LIST OF TABLES

IMPLEMENTING EMBEDDED TRAINING (ET):
VOLUME 4 of 10: IDENTIFYING ET REQUIREMENTS

SECTION 1

INTRODUCTION

One major step in developing an embedded training (ET) component for a system is defining the ET requirements (ETRs) for the system. ETRs are a first approximation to the training content and structure for the ET component. The ETRs are the tasks and/or behavioral performance objectives that should be supported by an ET component. Actual design of an ET component to meet the ETRs is a follow-on activity to ETR development.

The Iterative Nature of the ETR Identification Process

It is important to understand the iterative use of the ETR identification procedures in the system development process. These procedures are not intended to be simply used once. They should be exercised a minimum of two times in the process of defining an ET component for a system. In some cases, where a system matures slowly, or different subsystems mature at different rates, more than two iterations of the ETR identification will need to take place.

Iteration One: Preliminary ETRs

The first use of these procedures should take place during the pre-Concept Exploration phase of system development (if the conventional life cycle systems management model, or LCSMM, is used) or during the Requirements and Technological Base phase (if the Army streamlined acquisition process, or ASAP, is used). ETRs defined at this point will probably be based on early comparability analysis (ECA) or other estimation data, where required system operator activities can be defined only to a task (or in some cases, functional) level. This level of detail will not support identification of ETRs at the level needed to design an ET component (detailed behavioral objectives). This means that ETRs from the first iteration should be considered preliminary.

The preliminary ETRs are intended as an estimate of what ET may need to be supported by a new system, but probably are not a sound basis for designing the ET component. Thus, they must be updated when detailed data on the system under development become available. The preliminary ETRs provide input into the design of the total training system concept. This concept in turn provides important information

used in preparing several requirements documents for the new system. These are:

1. Justification for Major System New Start (JMSNS).

2. Organizational and Operational plan (O&O plan).

3. System MANPRINT Management Plan (SMMP).

4. Phase One System Training Plan (STRAP).

5. Tentative Required Operational Capability (TROC).

The "broad look" at ETRs provided by the preliminary analysis also allows some early ET-related input to the system design process. ET is typically implemented by integral or strap-on computer capabilities of the prime item system. If there are many ETRs, and something is known about the requirements to implement the ETRs, then provisions can be made to include the appropriate computer processing and memory capabilities in the system to implement ET. Otherwise, the needed capabilities could be overlooked. This could mean that an effective ET component would be impossible or have undesired schedule or cost impacts.

Iteration Two: Early System Development

Once the new system is in the design stage (late Concept Exploration or early Demonstration and Validation for the LCSMM; Proof of Principle for the ASAP), more information is known about human performance requirements for the system. At this point, the ETR process needs to take place once again, to support identification of ETRs at the behavioral objective level. At this level, the ETRs can be used as input to the development of a preliminary ET component design for the system. In some cases, the second-iteration ETRs will not be sufficiently detailed (because of system maturity factors) to support the ET component design. In such cases, additional iterations may be required at successive stages of system development.

Later Iterations

Depending on the rate at which the system design becomes firm, additional iterations of ETR specification may be necessary. This is true particularly if major changes in the functional allocation between system and soldier performance requirements have taken place, or if there are significant design changes to the soldier-system interface (SSI), as a result of technical or user testing.

The need for additional iterations of the ETR identification procedures is most likely when the LCSMM is used to manage system development, since there is one more major phase involved in system acquisition than with the ASAP. Additional iterations of the ETR procedures may be needed during the full-scale engineering development

(FSED) phase of the LCSMM. Systems managed under the ASAP may also require additional iterations of the ETR procedures during the Development and Production Proveout stage, as the system matures.

Overview of the ETR Identification Process

The remaining four sections of this report present the detailed procedures and guidelines for identifying ETRs. The procedures are divided into four phases, each with several component steps. An overview of the phases of the process is shown graphically in Figure 1. The procedures in Phases One and Two are essentially identical to other training front-end analysis procedures. In fact, ETR identification may take place as a part of efforts to identify training requirements for a system overall, and to specify other training media and approaches. Where possible, duplication of effort should be avoided, and common databases and resources should be used for all training-related front-end analyses. These procedures allow ETRs to be identified independent of other training analyses, to suit cases where non-training-oriented people must identify ETRs, or where ETRs are defined independent of other analyses in support of total training system definition.

Phase One (discussed in Section 2) is concerned with identifying the higher-level components (tasks) of personnel performance which may be supported by an ET component. The procedures for Phase One provide the first part of a complete-in-itself process for ETR identification without the need to refer to other documents.

Phase Two (described in Section 3) presents procedures for conducting task analysis to identify the behavioral performance objectives which are components of the tasks identified in Phase One. These procedures are exactly analogous to other task analysis procedures, and are presented here for completeness. Since preliminary identification of ETRs in early stages of the system life cycle may be required, this Phase of the process is shown as optional. This is solely due to the fact that complete, valid data on which to base a detailed task analysis may not be available early in the life cycle, even if HARDMAN or other ECA analyses are performed. If Phase Two is initially skipped, a detailed definition of the ETRs, based on a comprehensive task analysis, must be performed as early as possible, later in the system life cycle, when data become available.

Phase Three (discussed in Section 4) is specific to ETR decisions. Procedures in this Phase are concerned with nominating objectives as ETRs, based on perishability and criticality criteria. (Note: When "objectives" are referred to in Phase Three, and following, this refers to the maximum level of detail achieved in previous phases. For

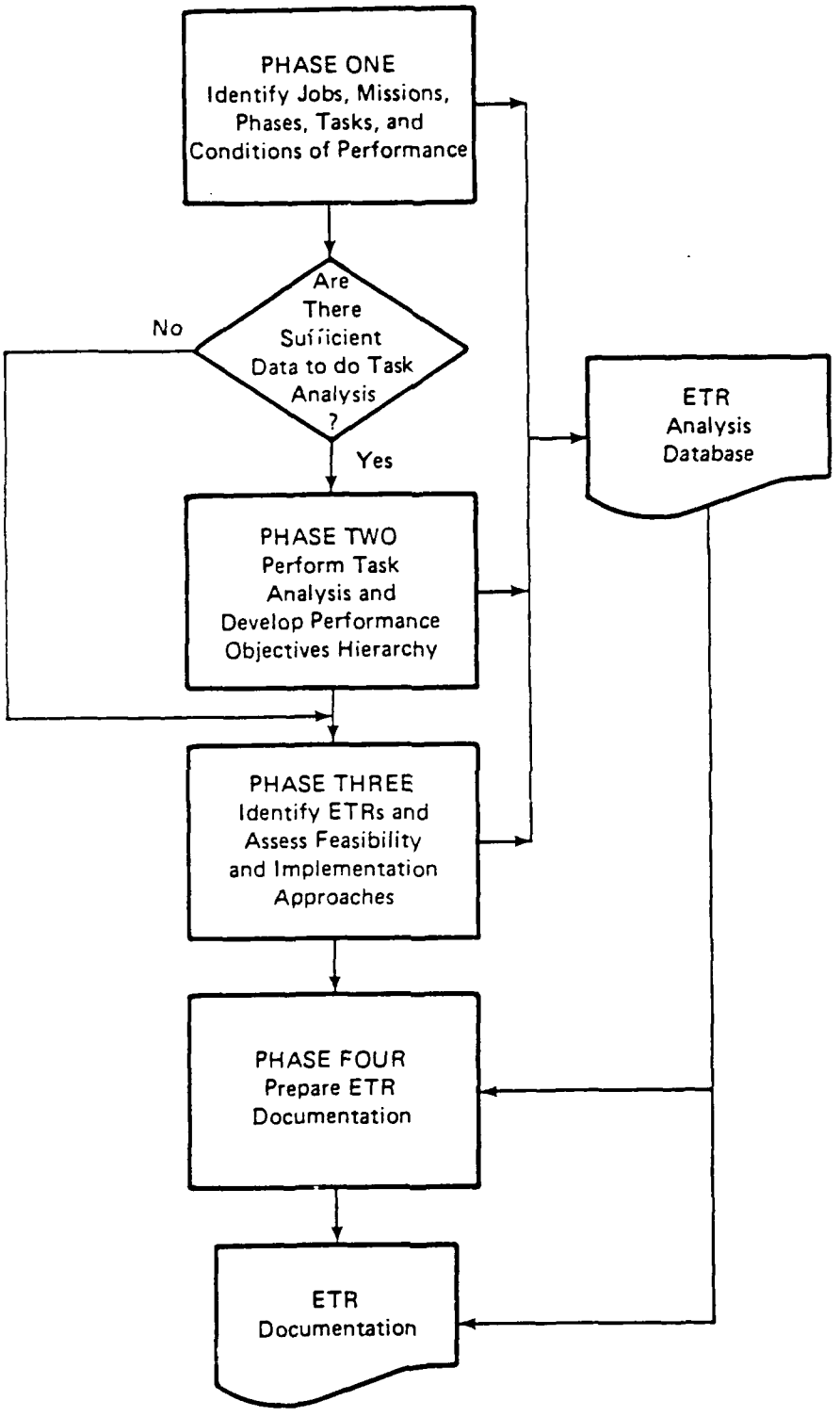


Figure 1. Overview of the Embedded Training Requirement (ETR) development procedures.

example, if Phase Two is not performed, "objectives" refers to task-level data. If Phase Two is performed, "objectives" refers to behavioral performance objectives or task components identified in Phase Two.) These procedures also assess the implementation potential of the nominated ETRs and identify possible approaches to implementation. Note that these analyses may be performed along with other training system analyses with similar purposes. These analyses should be conducted in parallel with, or integrated with, total training system media determination procedures, where possible. Combining the analyses will yield opportunities to examine overall training system alternatives and perhaps optimize the design of the complete training system.

Phase Four (detailed in Section 5) deals with presenting the identified ETRs. In practice, the database resulting from the analysis phases tends to become quite large. During ETR analyses, many data elements become associated with each task or behavioral performance objective. In Phase Four, specific reports are selected and prepared which emphasize various useful facets of the data, and which can be used for different purposes later in the development of an ET component.

The Appendixes

In addition to the four sections that present the procedures, three Appendixes are included to support the ETR identification process. Appendix A provides a generic mission phases model which is useful in Phase One, where system missions are decomposed into phases as part of the task identification process. Use of this model, adapted to the situation surrounding a particular system, is encouraged, to provide consistency. Appendix B presents an extensive listing and definition of action verbs for use in writing task and objective statements in the analysis process. This verb list is included to provide a standard reference for analysts.

Appendix C presents information concerning the application of computer database management systems (DBMSs) to support the ETR analyses, and documenting the results of the analyses. In practice, it has been found that the use of a DBMS on personal computers is a genuine resource-saver in conducting the ETR analyses and developing reports and documentation. In Appendix C, a suggested structure for DBMS records is provided. This data structure has been found to accommodate the ETR analyses and documentation effectively. Interim manual and computer-generated recording forms and formats are also presented, and their application in the steps of the ETR analyses is identified. Some suggestions on the use of DBMS capabilities in various parts of the ETR analyses are also provided in this Appendix.

SECTION 2

PROCEDURES FOR PHASE ONE: TASK CHARACTERIZATION

In order to develop valid ETRs, the first step is to completely define the activities, or tasks, that system personnel perform on the job. The tasks will be analyzed in more detail and considered for ET in later phases of the ETR development process.

The steps to be performed in Phase One, and the products that are produced, are summarized in Figure 2.

The results of the activities may be entered into a computer database for ease of management. It is strongly suggested that a computer DBMS be used to record and structure analysis results and data, if a DBMS is available and if you are familiar with its use. Using the computer database will also make many of the activities in later steps and phases easier, because of the flexible ways that appropriate DBMS software can manipulate and retrieve data. A suggested structure for a computer database for ETR analyses is given in Appendix C of this document. Good results have been had in ETR data management using personal computers with hard disks and several types of data management software. Any computer with hard-disk storage, and any data management software available, can be used. The goal is to provide consistent data management and to ease the burden of recordkeeping and data retrieval imposed by the large number of steps required to specify ETRs.

If computer database capabilities are not available, or if significant resources would be required to be able to use a computer database, manual recordkeeping is perfectly acceptable. If manual recordkeeping is done, it is recommended that the report formats in Appendix C be used as data forms.

The subsections that follow describe each of the steps in Phase One. Each subsection presents the objective of the step, provides rationale for the activities in the step, describes how to perform the step, and specifies the products that should result and how they should be recorded and documented. The steps should be performed in the order they are listed, since the activities in each step make use of products from previous steps.

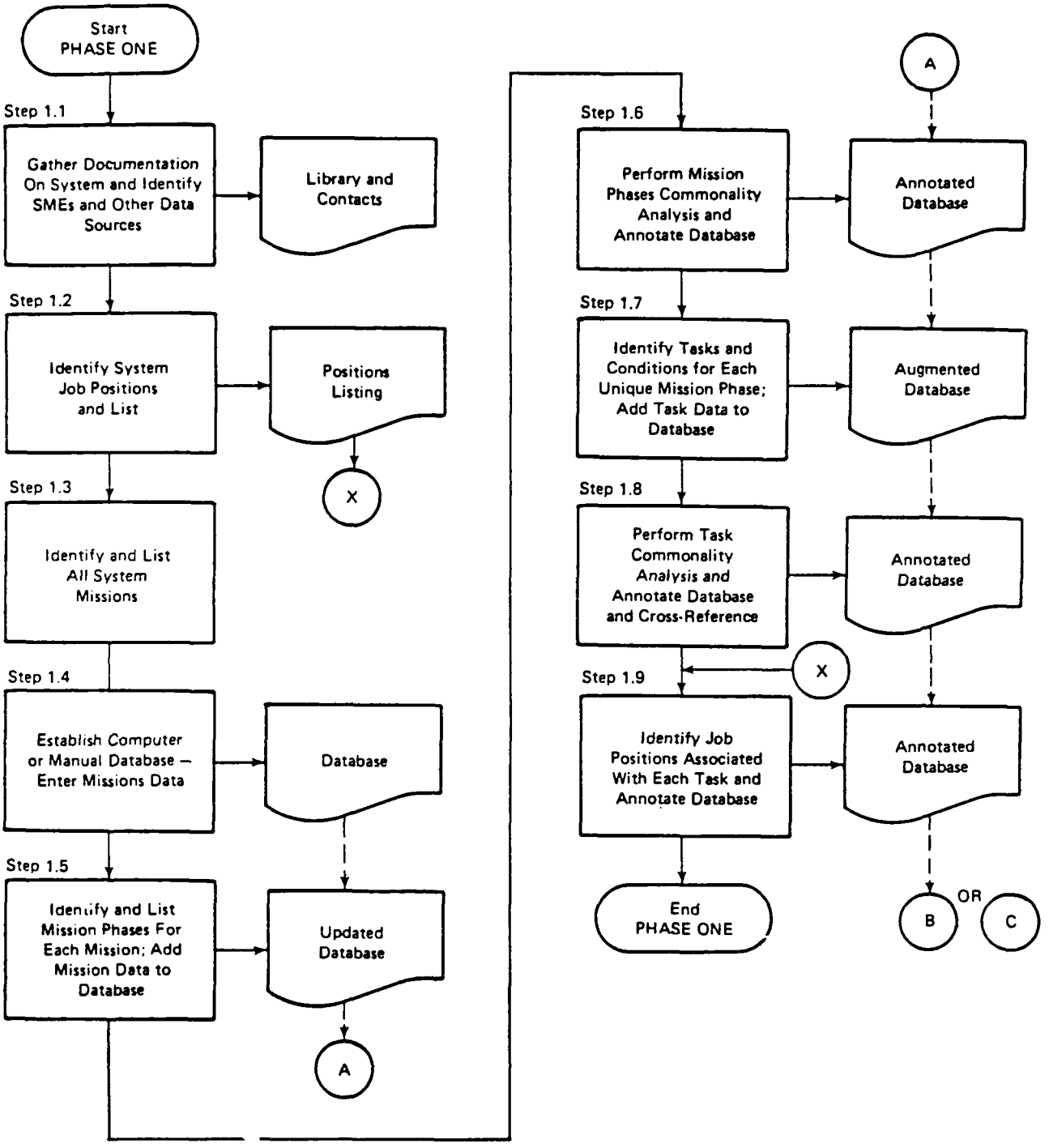
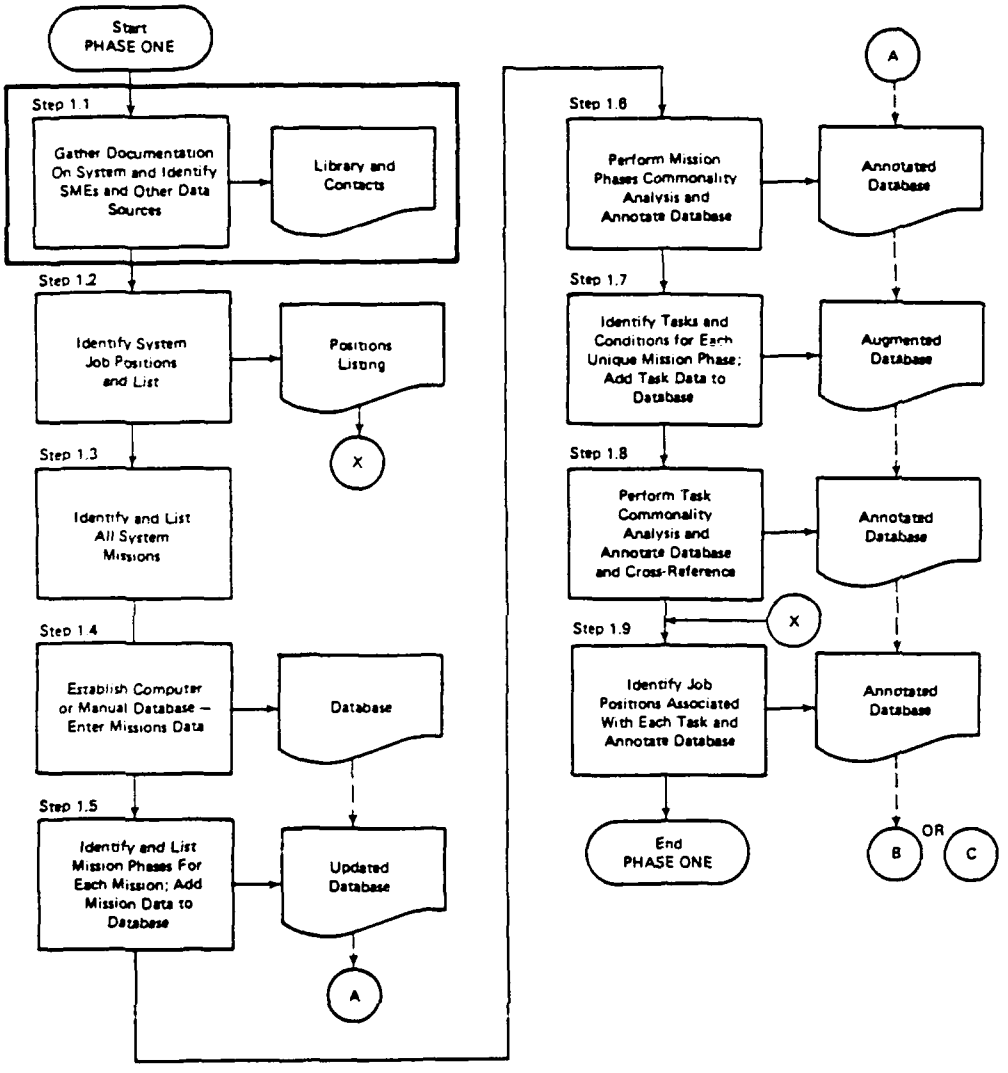


Figure 2. Overview of Phase One procedures.

Step 1.1: Gather Documentation on System and Identify SMEs and Other Data Sources



Step 1.1: Gather Documentation on System and Identify SMEs and Other Data Sources

Objectives:

1. Identify available information sources (people and organizations) about the system for which ETRs are being developed.

2. Develop a library of reference material (documentation on the system and the activities performed by people who operate the system) to support analysis.

3. Identify subject matter expert (SME) resources to provide additional information about the tasks that people perform and the important characteristics of those tasks.

Rationale: The analyses to define ETRs depend completely on accurate, comprehensive, detailed information about what people are required to do to make the target system perform effectively. This information provides the basis for developing training objectives and training content. It also assists in deciding which aspects of job performance should be supported by ET. Both documentation resources and people resources (SMEs) are normally required, to provide the information necessary for the development of ETRs for a system.

ETRs may be analyzed either early in the system development process or after the system has been fielded. If the ETRs are analyzed when a system is in the very early stages of its life cycle, information sources that are accurate and complete are likely to be hard to come by. When this is the case, the documentation that is available must be used. However, it does not support a very detailed level of analysis. Documents which describe the system, its missions and capabilities, and the responsibilities of personnel at early stages of the life cycle include mission area analysis (MAA) documentation (Mission Area or Battlefield Development Plans), required operational capability (ROC) statements, and O&O Plans for the system. Other documentation, including results of ECA or HARDMAN analyses and MANPRINT studies (including the system MANPRINT management plan [SMMP]—particularly the Target Audience Description), may also be available. Some or all of these documents may have been gathered to support previous ET analyses (evaluating ET as a system alternative [Volume 2 of this series], or identifying the role of ET in the training system concept [Volume 3]). If so, such documents can be used to support ETR analyses. Also, products from using the procedures in Volumes 2 and 3 of this series may be of help in getting started.

If necessary, documentation about other systems that have similar missions or are similar to the target system (in

design or technology) may be used. If this is done, however, a later update of the ETR analysis (using accurate, complete information on the actual target system) will be necessary.

In some cases, the addition of ET to a fielded system may be considered. If the ETR analysis is performed after the system has already been fielded, large amounts of documentation on the system and the tasks and responsibilities of its personnel are typically available. These information sources are generally complete and accurate, especially if the results of other training analyses on the system can be obtained. Documents that are useful at this stage include technical manuals (TMs) dealing with the target system, field manuals (FMs) describing how the system is operated and employed, and soldier's manuals (SMs) that describe the responsibilities and tasks of the crewmembers or system operators of the target system. Task analysis (for example, Logistic Support Analysis Records [LSAR]) and training Front-End Analysis information is also useful, as are the results of any ISD analyses that have been done on the target system.

SMEs provide two critical services in an ETR analysis. First, they can validate or revise questionable information, and add details that may not be present in documentation. This is especially important in the case where information is sparse or incomplete. Second, SME input is required to make judgments on how critical specific aspects of job performance are to mission accomplishment, when identifying tasks or performance objectives to be included in the ETRs.

Procedure: The first activity in this step is to identify agencies capable of providing the necessary documentation and the personnel who can serve as SMEs. While details will differ from system to system, sources include Project Manager's staff, Special Study Group (SSG) staff and reports, Special Task Force (STF) staff and reports, Army Materiel Command (AMC) personnel associated with the system, Training and Doctrine Command (TRADOC) Training System Managers (TSMs), personnel in the Directorates of Training and Doctrine (DOTD) and Combat Development (DCD) at the proponent school for the system, and personnel associated with the system at various laboratories and commodity commands (e.g., Army Missile Command, etc.).

After sources have been identified, they should be contacted, and the documentation available from each source should be requested. In most cases, it is recommended that all available documentation be identified and obtained. If

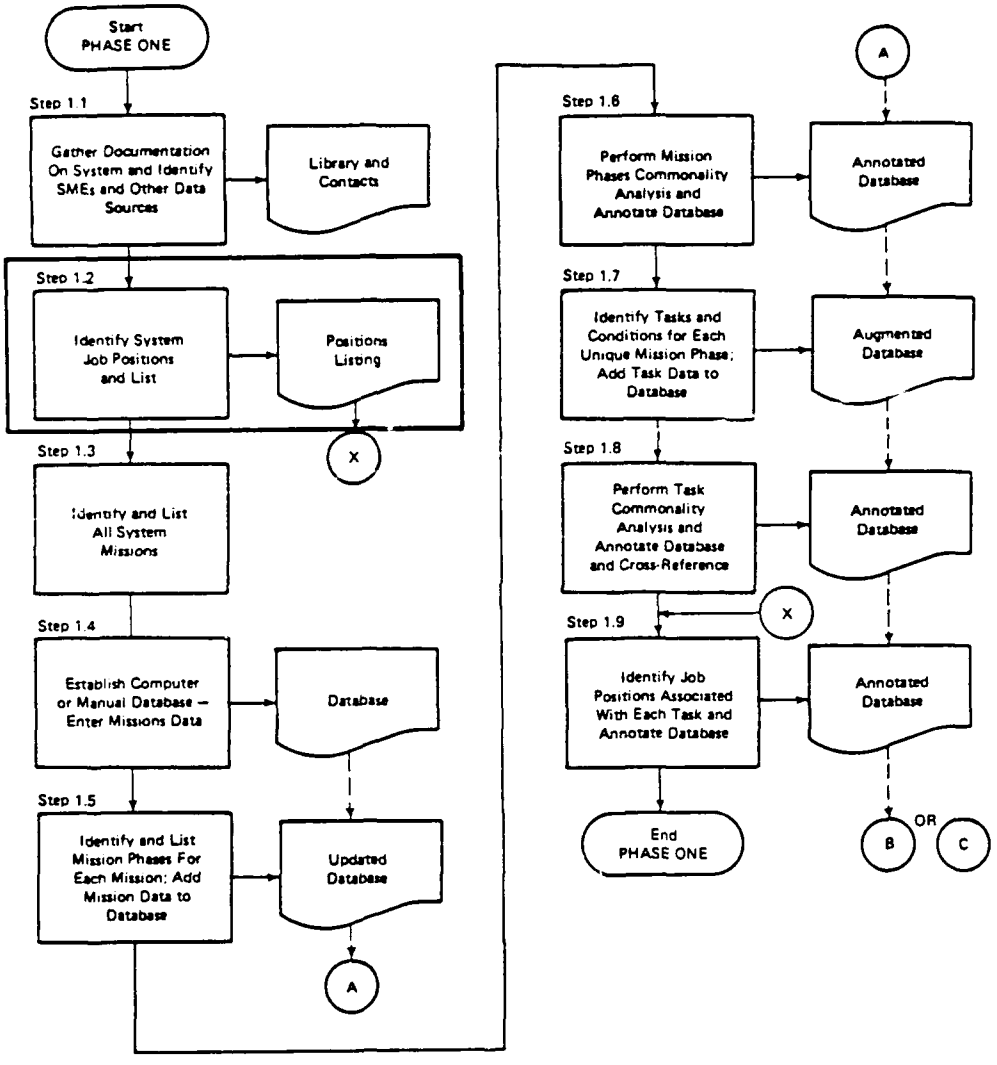
more information than is useful is obtained at this point, it is better than if insufficient information is available later.

Once documentation has been received, it should be catalogued, and a project library should be established for ease of reference. If the volume of documentation is large, it may be helpful to develop a computer database for cataloguing or indexing the information sources for ease of reference in later steps. This can also be helpful when developing an audit trail (i.e., where the information used in the analysis came from) in the analysis database in later steps, since source-identification data can be easily transferred from one database to another.

SMEs are frequently more difficult to come by than is documentation. The ideal SMEs to support an ETR analysis are relatively senior enlisted personnel (Skill Level 3 or higher in military occupational specialty [MOS]) who have a minimum of one year's recent experience on the target system or on very similar systems. It is highly desirable to have two or more SMEs available, especially at critical points in the effort, so that different perspectives on decisions are available. Continuous SME involvement is not absolutely required over the entire period of the ETR analysis, but is desirable, if possible. If SMEs cannot be made available on a continuous basis, their involvement at specific points in the analysis process is critical. The steps where SME assistance and input are essential are indicated later in this document, as they are described. In any case, it is highly desirable to have the same SMEs involved over the project period, in order to minimize the amount of re-familiarization required and its associated delays.

Products: The products of this step are the project library, the lists of personnel or offices in various agencies which may be contacted for additional information, and the identification and assignment of specific SME personnel to support the project.

Step 1.2: Identify System Job Positions and List



Step 1.2: Identify System Job Positions and List

Objective: Identify each job position involved in operation of the target system, including (if possible) MOS, grade, and other specific descriptors.

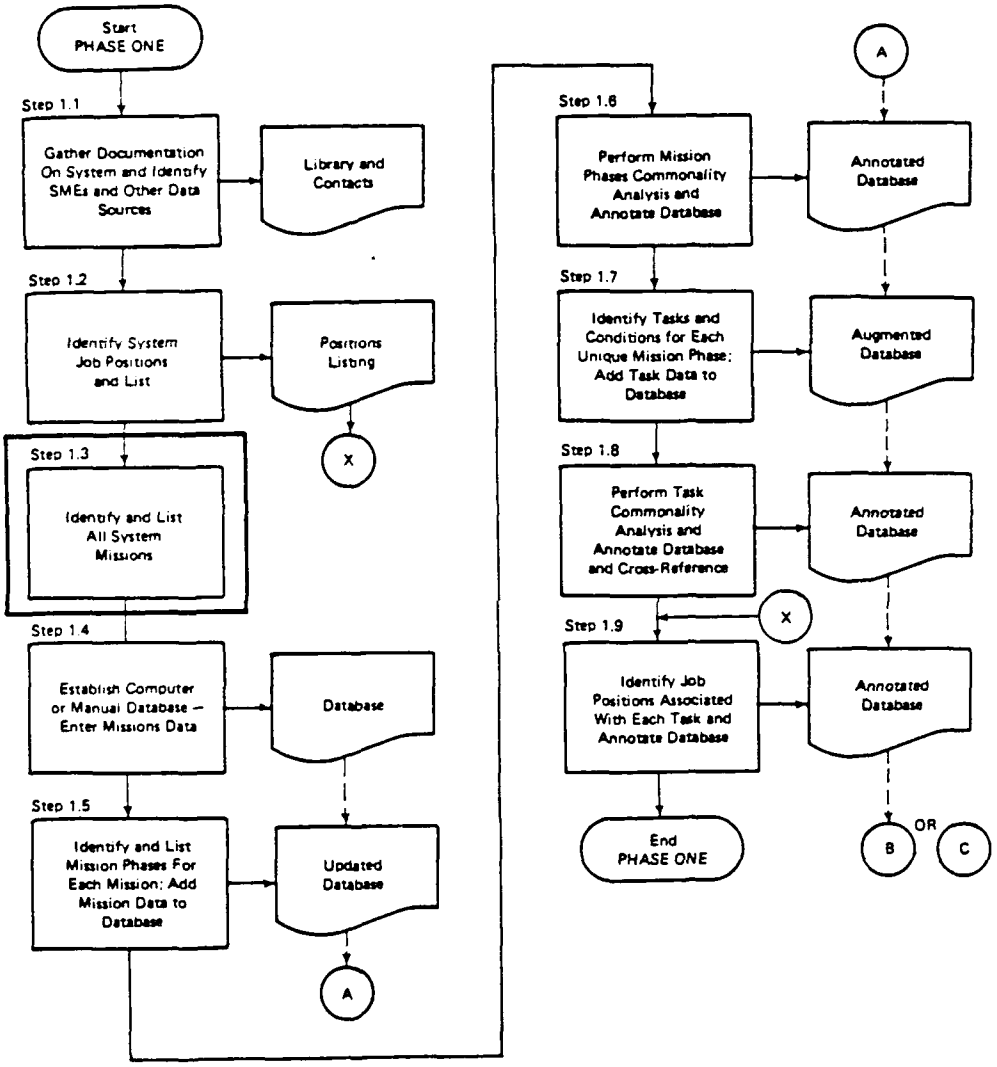
Rationale: The first two phases of the ETR analysis are a top-down analysis of the responsibilities, tasks, and performance of personnel who operate the system. It is necessary to be able to identify which people do what on the system, and under what circumstances, in order to identify valid ETRs. Also, when an ET component is developed for the system, it is necessary to identify which personnel will interact with the ET component, and in what ways.

Procedure: Examine the available documentation and determine the titles of job positions involved in system operation. Job position titles should be descriptive of the general duties performed by each person involved in system operation. For example, an M109 howitzer crew is normally composed of five persons: a Chief of Section, a Gunner, an Assistant Gunner, a Driver/Cannoneer, and a Cannoneer.

After the job position titles have been identified and listed, additional descriptive information about each position should be determined. As a minimum, the MOS and grade for each position should be identified. Other information, such as special qualifications and prerequisites for each position, should be listed if it is conveniently available.

Product: The job position listing. Later, this listing will be used to identify which positions are involved in performing tasks and task-component activities on the system.

Step 1.3: Identify and List All System Missions



The use of Form 1 (see Appendix C) for interim data recording is suggested for this step

Step 1.3: Identify and List All System Missions

Objective: Identify and list all of the named missions (or functional areas) which are to be performed by the target system.

Rationale: Since the identification of tasks and personnel responsibilities is a top-down process, a point of departure is needed. Since most systems are designed to fulfill specific missions (or have analogous distributions of functions), beginning the analysis at the mission or functional-area level provides a consistent starting place for the ETR analysis. Also, reviewing the missions (or functional areas) provides a relatively complete picture of how a system is to be used. This helps to make the analyses complete by providing for the various unique uses of the system.

Procedure: Using documentation and SMEs (if available), list each mission performed by the target system. An excellent resource for mission listings data is the O&O concept for the system. This document normally lists all missions and mission variants contemplated for the system. An additional advantage of the O&O concept as a resource is that it is normally prepared very early in the system life cycle. More stable data for systems which are in later parts of the life cycle are typically found in FMs, SQTs, TMs, and ARTEPs.

When considering missions, guidelines useful for discriminating missions are the following: (1) a mission is a related set of activities normally performed by a crew or other system of individuals, (2) a mission has clearly definable beginning and ending points, and (3) missions are often related to specific end goals of coordinated crew activities.

It should be recognized that not all systems will have more than one mission. For example, tanks may have many missions, but an anti-tank weapon may have only one. Tanks can have both direct and indirect fire missions, and can be employed in counter-armor, counter-asset, offensive, and defensive roles. These could all be considered distinct missions. On the other hand, anti-tank weapons are used to kill tanks, and for very little else, except in very unusual circumstances. In general, the more flexible the overall capabilities of a given system, the more missions it may have, other factors being equal.

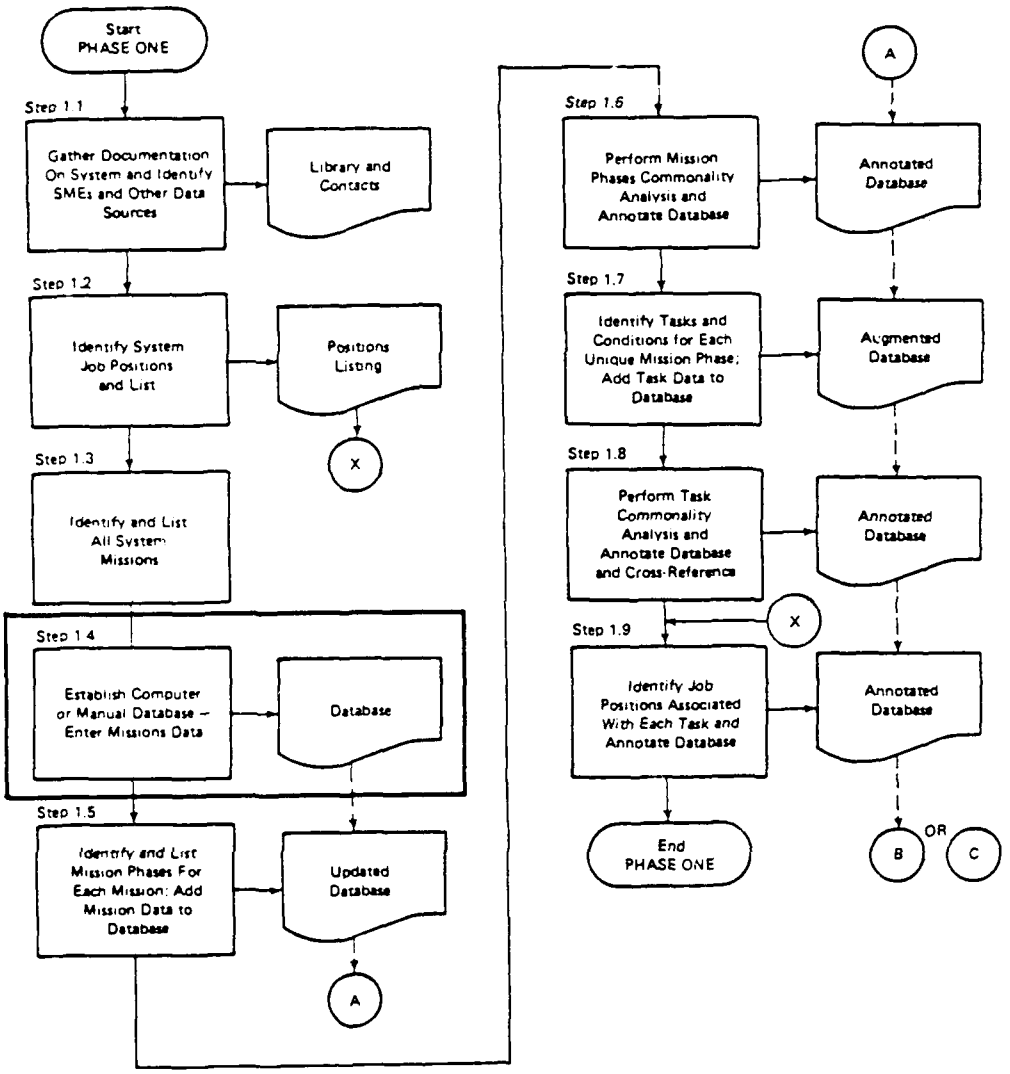
In some cases, systems do not have named missions. Rather, there may be some other breakdown of functional requirements for a system. For example, some command,

control, communications, and intelligence (C3I) systems support various functions (intelligence gathering, database management, intelligence analysis, electronic mail, etc.) that are analogous to the missions performed by weapon systems. If this is the case, some appropriate functional breakdown should be identified and used in the ETR analysis.

Product: The listing of unique missions (or analogous functional areas) for the system.

NOTE: In the rest of this document, the term "mission" refers to both missions and to other functional breakdowns that may be used.

Step 1.4: Establish Computer or Manual Database - Enter Missions Data



The use of Form 1 (see Appendix C) for interim data recording is suggested for this step

Step 1.4: Establish Computer or Manual Database - Enter Missions Data

Objective: Develop and implement a complete and comprehensive database to support documentation and analysis in subsequent steps of the ETR identification process.

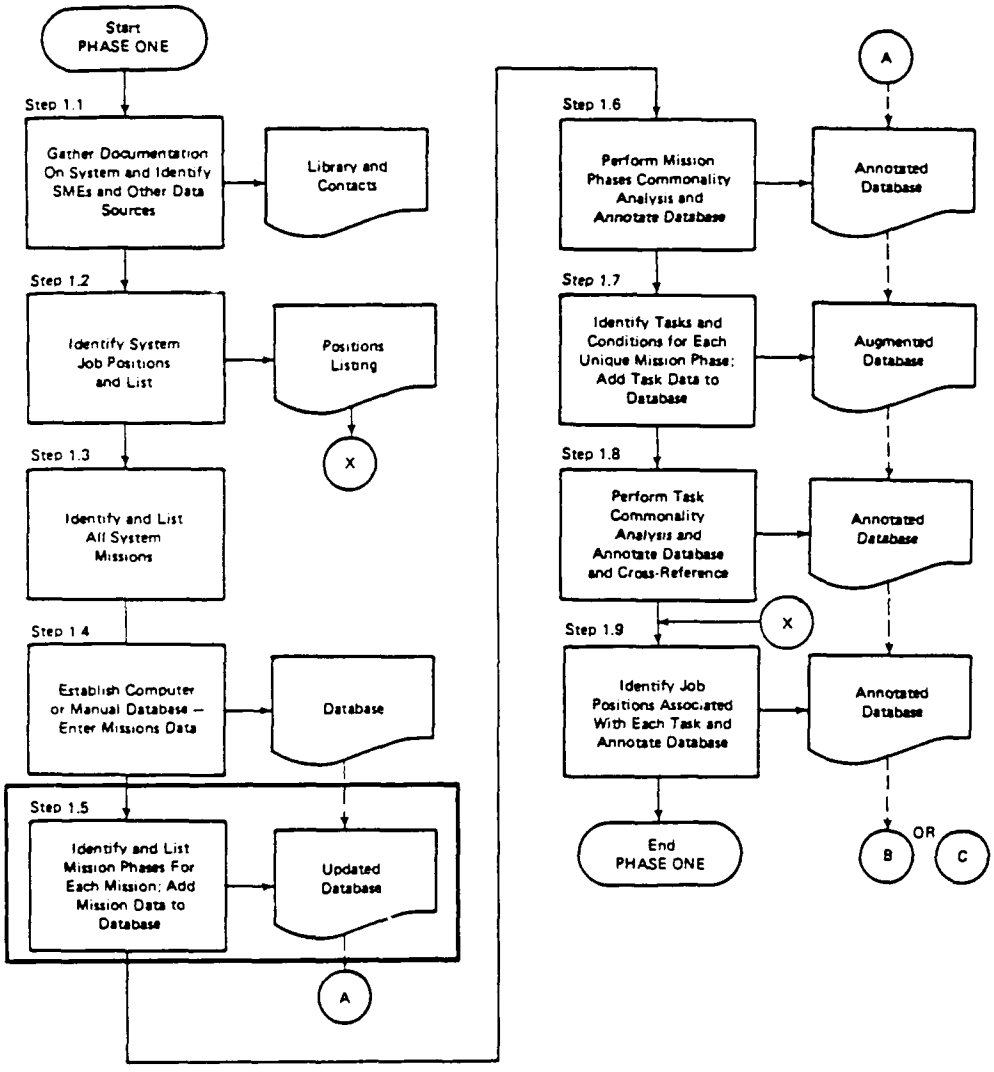
Rationale: Using a computer database management system to support the ETR analyses saves time in the documentation of most steps, and makes the retrieval, modification, and analysis of data much easier. Database management software also facilitates preparation of reports for the intermediate and final steps of the ETR development process, and provides for a consistent and comprehensive level of detail in the data. If it is not feasible to use a computer database, then use Appendix C to set up a manually managed paper database. The suggested forms in Appendix C can be reproduced to support a manual system.

Procedure: Using available database management software (or a manual system), establish a data structure similar to that presented in Appendix C of this report. All of the data fields described in Appendix C should be defined in the data structure that is implemented.

After the data is implemented, enter the discrete missions (or functional areas) identified in Step 1.3 as individual records in the database, with appropriate codes and descriptions. If only one mission was identified in Step 1.3, there is no need to enter mission records. Also, enter the data sources that were used to identify each mission.

Products: The implemented data structure and mission descriptor records (if applicable).

Step 1.5: Identify and List Mission Phases for Each Mission; Add Mission Data to Database



The use of Form 1 (see Appendix C) for interim data recording is suggested for this step

Step 1.5: Identify and List Mission Phases for Each Mission; Add Mission Data to Database

Objective: Identify all discrete mission phases for each system mission and add the mission phase data to the database.

Rationale: Decomposing missions into phases is the next step in the top-down analysis to develop the complete database for identifying ETRs.

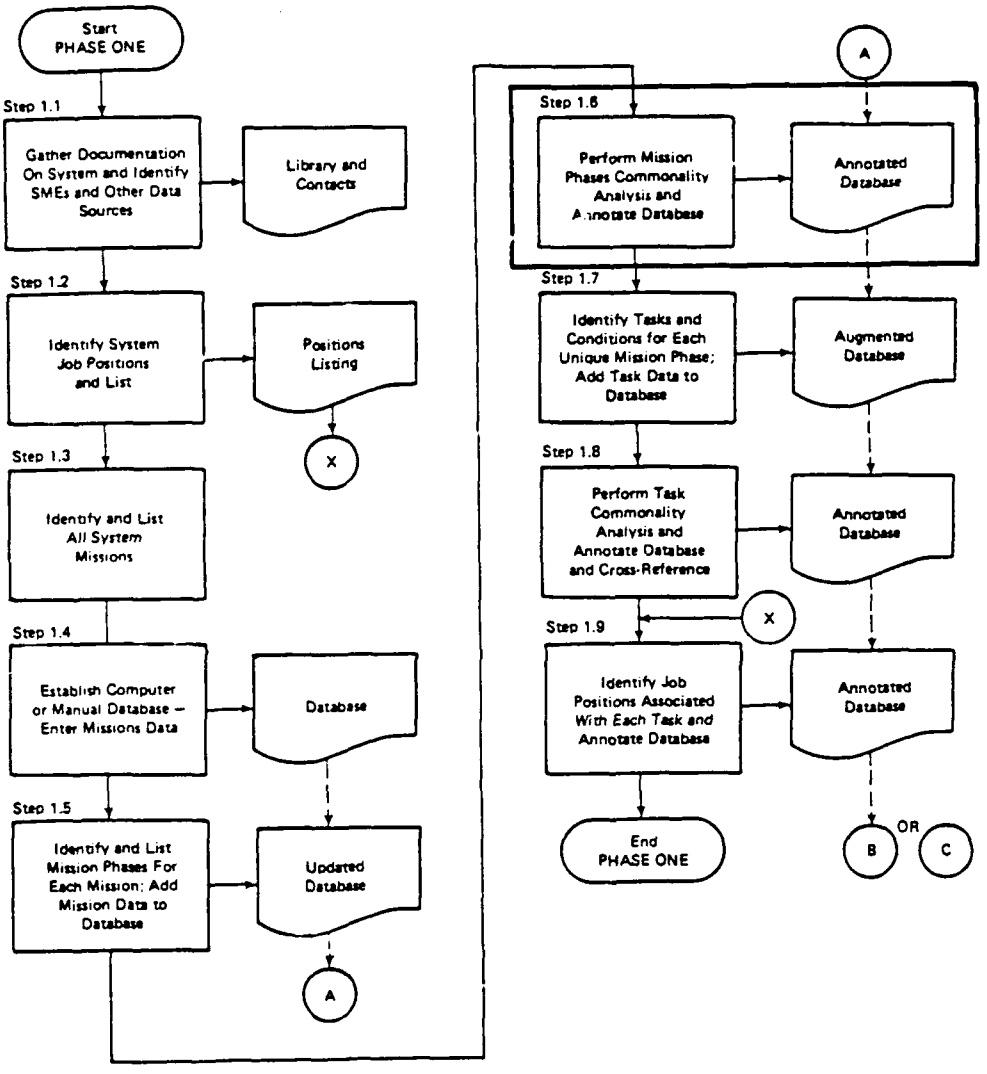
Procedure: For each of the missions identified in Step 1.3, use documentation and SME resources to identify the phases of the missions. Mission phases have the following characteristics: (1) each mission phase can be given a meaningful name, (2) each mission phase has a logical beginning and ending point, (3) each mission phase occupies a unique time slice within the mission, and (4) all phases taken together describe an entire mission.

Good sources for mission phase description data are SMs, TMs for the system or for very similar systems (if available), SMEs, and other persons (e.g., combat developers, other departments of the contractor organization) working on the problem for other reasons. When SMEs are used to identify mission phases, they should be briefed on the four characteristics listed in the previous paragraph, and provided documentation for reference. If desired, the generic mission phases model presented in Appendix A can be used as a starting point for mission phase identification. It will probably be necessary to adapt this generic model to the specific system that is being considered. Also note that the generic mission phases model is based on typical ground weapon system missions. Aircraft systems and non-weapons systems may have very different mission phase breakdowns. Some non-weapons systems may not have mission phase structure at all. However, such systems usually have functional groupings of tasks that are analogous to mission phases. Such task groupings can be used to organize the remainder of the analysis process, instead of mission phases.

As mission phases (or other functional groupings) for each mission are identified, they should be listed, by mission. Also, the documents or other sources used to derive the mission phases should be recorded, to provide an audit trail for the analyses. After identifying phases for all missions, enter the mission phases for each mission as records in the database. Codes used for the mission-phase records should be one level subordinate to the codes used for mission records. Also, the codes assigned to phases of each mission should reflect the sequence of the phases in the mission.

Product: Mission phase listings for each mission, entered as mission phase records in the computer database.

Step 1.6: Perform Mission Phases Commonality Analysis and Annotate Database



The generation and use of Form 2 (see Appendix C) for interim data recording is suggested for this step

Step 1.6: Perform Mission Phases Commonality Analysis and Annotate Database

Objective: Identify and annotate the unique mission phases among the various missions. (NOTE: This step may be omitted when there is only one mission or functional task area defined for a system.)

Rationale: Later steps in the analysis process may consume large amounts of time and resources. If several missions have identical phases, it makes no sense to duplicate effort in analyzing the tasks and operator behaviors contained in such phases more than once. This step identifies the phases that are unique among all the missions identified. Only the unique mission phases will be considered in later steps.

Procedure: Obtain a listing of mission phases (sorted or indexed by mission) from the database. Use this listing to identify the phases in different missions that have similar or identical titles. Using SMEs as a primary source, review all of the mission phases that have similar or identical titles in different missions, and judge which of these phases are unique. An appropriate approach is to consider all possible pairs of mission phases with similar titles. Questions to ask when trying to determine if phases with similar titles are, in fact, identical are:

1. Are there different goals or objectives among mission phases with similar titles? If yes, the phases may be unique.

2. Is the system or its subsystems used in different ways in mission phases with similar titles? If yes, the phases are probably unique.

3. Are there differences in the responsibilities allocated among operators or crewmembers across phases with similar titles? If yes, it is likely that the phases are unique.

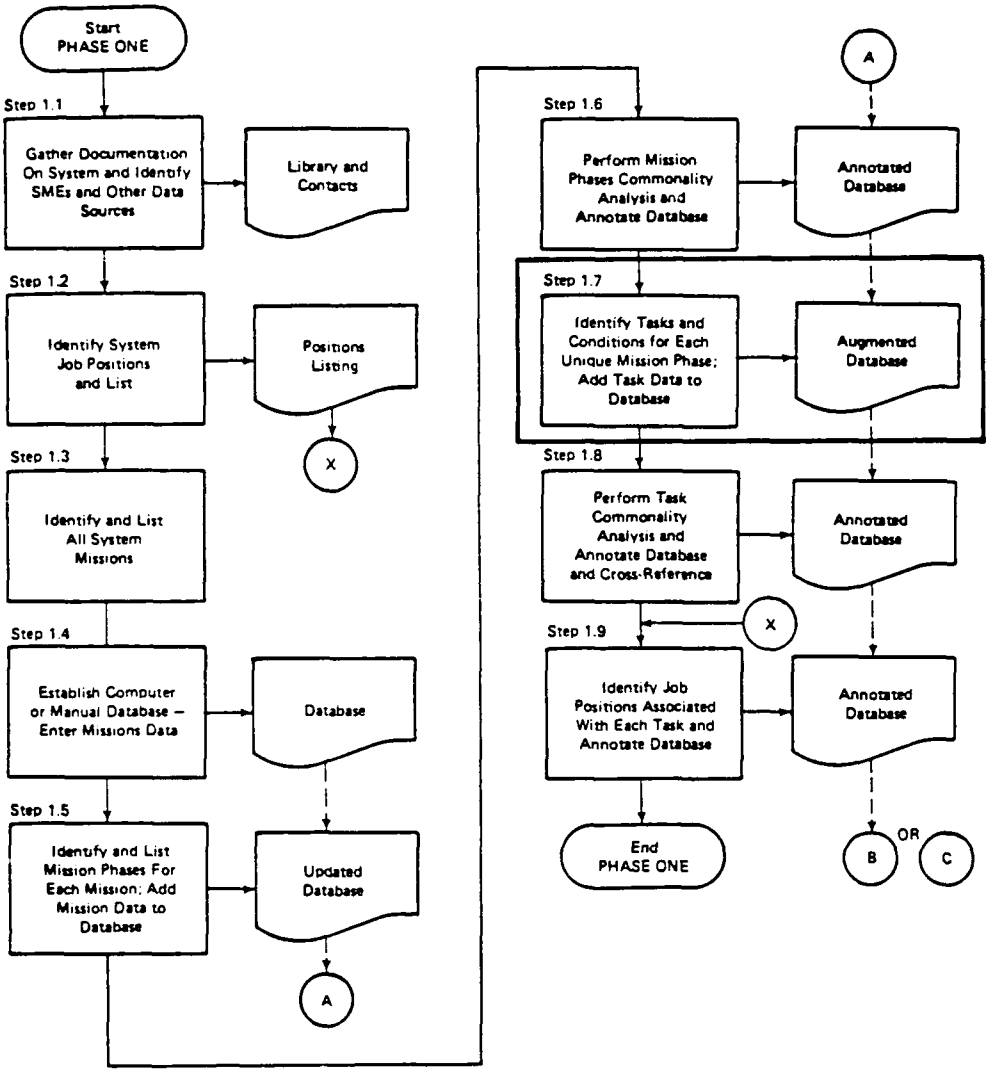
As the phases are evaluated, identify the first occurrence of identical phases. Then identify each phase that is identical to these first ones. Generally, the "first occurrence" phases should be those with lower numbered mission codes in the database.

After all phases have been evaluated, annotate the mission-phase database records. Two kinds of annotation will be needed. The first is to identify the unique phases and the "identical" phases that are the same as the unique ones. Using a logical database field, code the unique

phases as "True" and the "identical" phases as "False." The second kind of annotation is a cross-reference of the phases that are identical. It is suggested that the database codes of all "identical" mission phases be listed in the appropriate field of the unique "first occurrence" phase to which they are identical.

Product: Database annotations indicating unique and "identical" mission phases, and cross-reference fields in the unique mission-phase records.

Step 1.7: Identify Tasks and Conditions for Each Unique Mission Phase; Add Task Data to Database



The use of Form 1 (see Appendix C) for interim data recording is suggested for this step

Step 1.7: Identify Tasks and Conditions for Each Unique Mission Phase; Add Task Data to Database

Objective: Identify all tasks performed by operators or crewmembers while performing each unique mission phase (or other functional break-out), and the conditions under which each task is performed.

Rationale: Decomposing mission phases into tasks is the next step in the top-down analysis to develop the complete database for identifying ETRs.

Procedure: The following procedures are performed for each unique mission phase or other functional break-out used. The primary information sources are documentation (SMs and ARTEP documents are good sources) and SMEs. Other useful data may come from application of procedures in Volume 2 (ET as a System Alternative) and Volume 3 (The Role of ET in the Training System Concept) in this series. If only documentation is used for initial identification of tasks, the task listings should be validated by two or more knowledgeable SMEs and should later be updated, as appropriate, based on their comments.

1. Go through each unique mission phase in sequence, identifying and listing all tasks. In identifying tasks, look for names of products produced by personnel while doing their duties, or names of processes they use to accomplish goals. Also, consider the following characteristics when identifying tasks:

    a. Tasks are significant operator activities that can be named.

    b. Each task has an observable beginning and ending point, or results in a consistently identifiable product.

    c. Most tasks include a consistent sequence of specific behaviors (these will be dealt with in Phase Two).

    Task names should consist of an action verb, a noun that specifies the object of the action verb, and an appropriate modifier (or qualifier) phrase that briefly describes how the action is carried out. Modifier phrases should be neither too detailed (getting into specifics) nor too general. For example, the task statement for manual laying of a howitzer might be "Lay howitzer, using manual method." A list of generic action verbs for use in developing task statements is

provided in Appendix B. Note that some special action verbs, such as to "lay" a howitzer, may be absent from this list, although they are common in traditional military usage. These should be used when necessary for clarity.

Provide sufficient detail to enable the listing to be validated by someone else using the same resources. If enough detail is not provided, important tasks may be omitted from consideration or be analyzed wrongly in later steps of the ETR identification process. Generally, an appropriate level of detail in listing tasks is considered to be: (a) the point below which task components would be described, rather than tasks and (b) the lowest level at which performance might be evaluated independently from other contiguous tasks. An example of a task statement that is not sufficiently specific is "Lay howitzer," since there are several methods for laying the howitzer. An example of a task statement that is too specific is "Select the manual alignment mode on the inertial navigation system." This is a behavioral component of a task.

As tasks are identified, they should be given numeric codes that reflect their level in the database hierarchy. Task codes are one level below mission phase (or other functional area) codes. For example, a code for the ninth task in Mission 1, Phase 6 would be 01.06.09. These codes will reflect the position and level of subordination of the task in the overall operator performance hierarchy.

2. After all tasks in a mission phase have been identified, organize the tasks so that all the tasks at each level in the task hierarchy are independent. Review each task, and ask the question, "Can this task be subsumed under any other task listed at this level for this mission phase?" If it can, then the task should be moved to a lower level in the hierarchy. Task statements at each level in the task hierarchy should be completely independent of each other--neither subordinate nor superordinate.

3. Continue identifying tasks in each unique mission phase until all of the mission phases have been analyzed. After completing the task identification for a mission phase, add the task data (task statements and hierarchy numeric codes) to the database as separate task records. Also, include the information source(s) you used to identify each task.

4. Identify the conditions of performance for each mission, phase, and task. Conditions are the "givens" of a performance. They describe the circumstances under which a task is performed. Conditions may include (but are not limited to) the following:

   a. Environmental factors (such as space, light, noise or quiet, temperature, wind, weather, or system conditions).

   b. Relationships to other personnel (alone, working as part of a team or crew, under supervision, etc.).

   c. Equipment factors (what job aids, tools, equipment, etc. are available or provided).

   d. Information (what job-relevant information is available at the workplace; checklists, operator manual, charts, etc.).

   e. Problem definition (what stimuli are present to signal that a task is to be initiated; system characteristics that provide cues and "feel," etc.).

   f. Time (duration, pacing, etc.).

   g. Concurrent tasks.

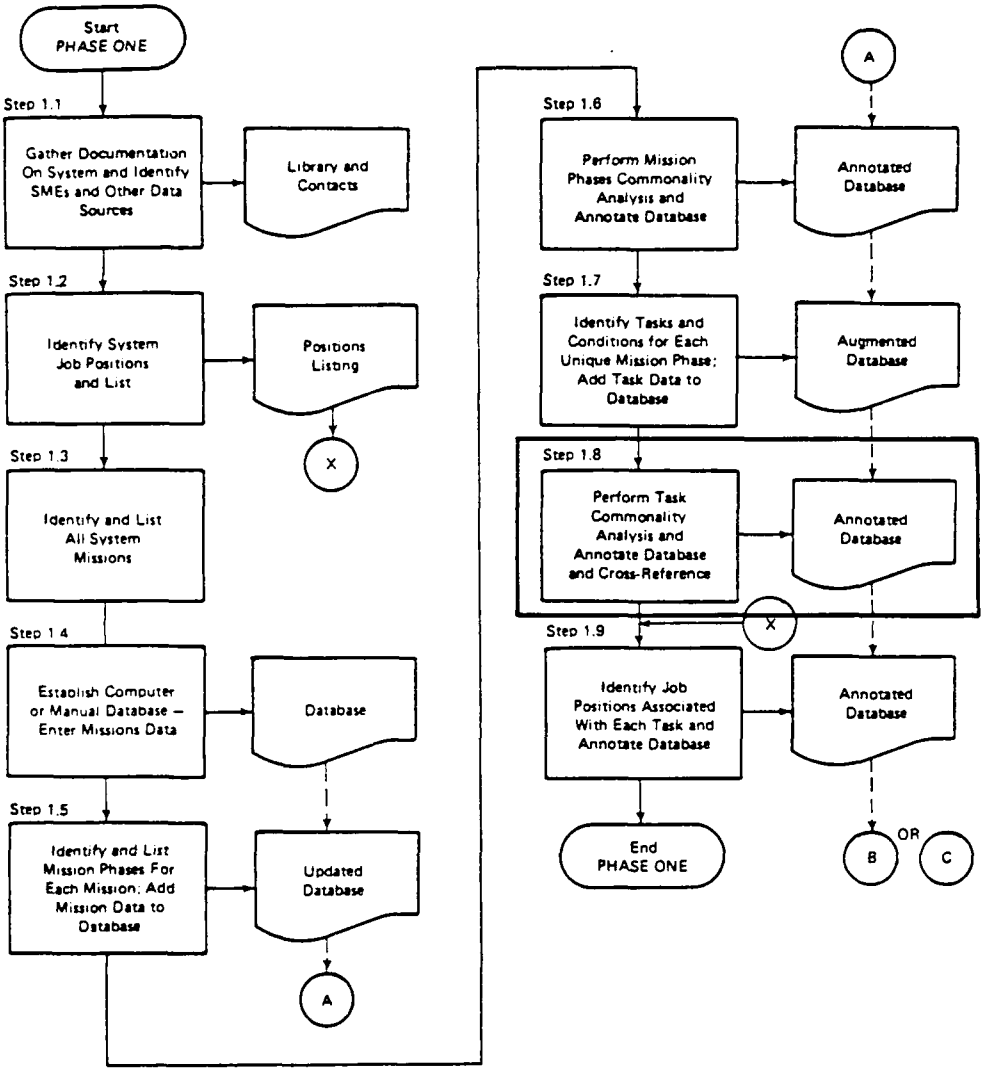
   Add the conditions information to each mission, unique mission phase, and task record in the database.

5. List all additional tasks required in each mission phase for performance under extraordinary conditions. Extraordinary conditions include malfunctions, emergencies, and abnormal system conditions (such as operating at half power because one of two engines has failed). This is best accomplished by asking, for each mission, phase, and task, "Are there any conditions under which this is performed that require deviations from normal procedures?" Note that SME input is extremely valuable at this step; documentation often deals only with normal system operation or operating under nominal conditions. The existence of extraordinary conditions requires the identification of tasks previously overlooked in developing the task listings. New tasks created by identifying extraordinary circumstances are added to the task database and are subsequently treated the same as any other task.

6. Re-examine and validate the task listing. Review the task listing against the available documentation, and with one or more SMEs who were not involved in the original development of the task listing (if possible), to identify possible omissions and errors. Add to the database any tasks that were overlooked, and correct any errors that were discovered during the validation process.

Product: The validated task data, added to the project database.

Step 1.8: Perform Task Commonality Analysis and Annotate Database and Cross-Reference



The generation and use of Form 2 (see Appendix C) for interim data recording is suggested for this step

Step 1.8: Perform Task Commonality Analysis and Annotate Database and Cross-Reference

Objective: Identify and annotate the unique tasks among the various mission phases (or other functional break-outs).

Rationale: Later steps in the analysis process may consume large amounts of time and resources. If there are identical tasks in several mission phases, it makes no sense to duplicate effort by analyzing these tasks (to identify their operator behaviors) more than once. This step identifies the tasks that are unique among all the tasks identified. Only the unique tasks will be considered in later steps.

Procedure: Obtain from the database a listing of tasks sorted or indexed by task statement. Use this listing to identify those tasks (in the same or different mission phases) that have similar or identical task statements. Using two or more SMEs as primary sources, review all of the tasks having similar or identical statements, and judge which of the tasks are unique. An appropriate approach is to consider all possible pairs of tasks with similar or identical titles. Questions to ask when trying to determine whether tasks with similar statements are, in fact, identical are:

1. Are there different goals or objectives among tasks with similar titles? If yes, the tasks may be unique.

2. Is the system or its subsystems used in different ways in tasks with similar statements? If yes, the tasks probably are unique.

3. Are there differences in the responsibilities allocated among operators or crewmembers across tasks with similar statements? If yes, it is likely that the tasks are unique.

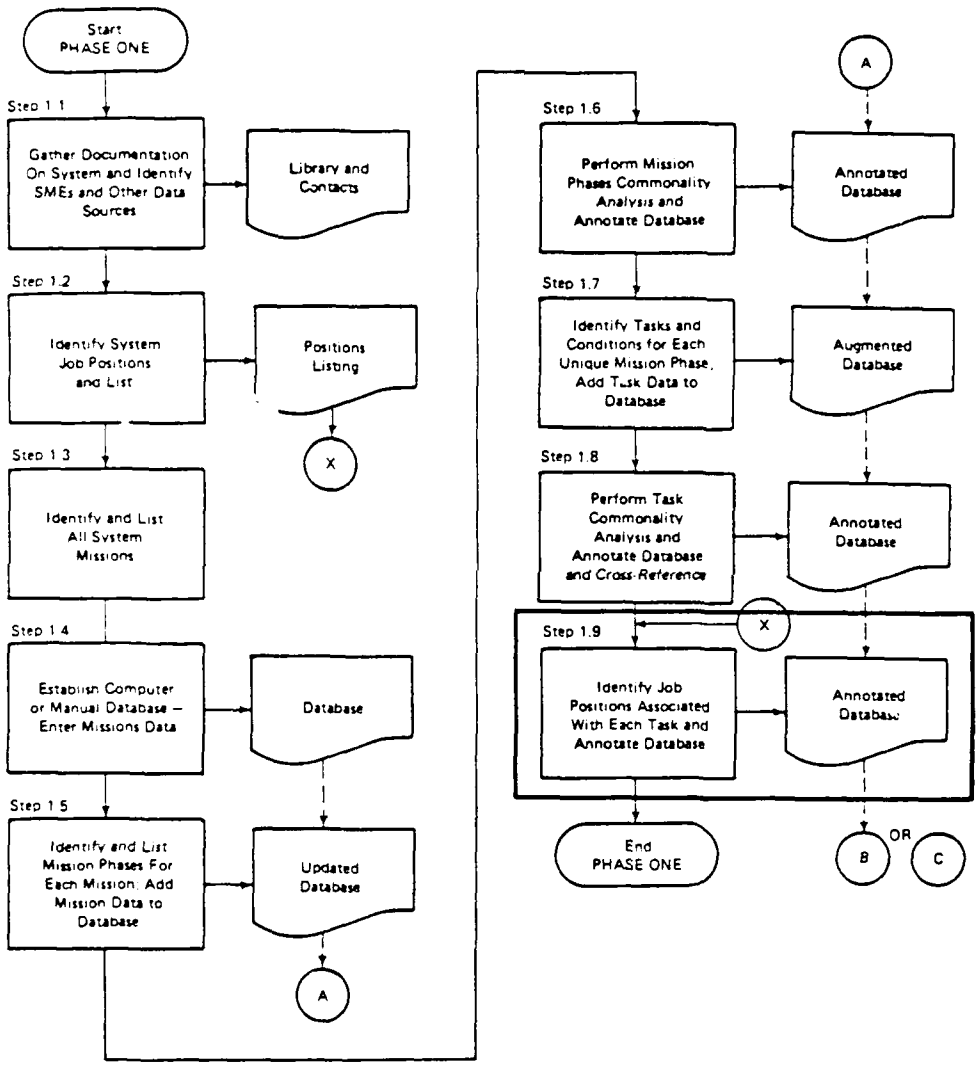
As the tasks are evaluated, identify those tasks that are the first occurrences of identical tasks. Also, identify each task that is identical to these "first occurrence" tasks. Generally, the "first occurrence" tasks should be those with lower numbered codes in the database.

After all tasks have been evaluated as described above, annotate the task database records. Two kinds of annotation will be needed. The first is to identify the unique tasks and the "identical" tasks that are the same as the unique ones. Using a logical database field, code the unique tasks as "True" and the "identical" tasks as

"False." The second kind of annotation is a cross-reference of the tasks that are identical. It is suggested that the database codes of all "identical" tasks be listed in the appropriate field of the unique "first occurrence" tasks to which they are identical.

Product: Database annotations indicating unique and "identical" tasks, and cross-reference codes placed in the unique task records.

Step 1.9: Identify Job Positions Associated With Each Task and Annotated Database



Step 1.9: Identify Job Positions Associated With Each Task and Annotated Database

Objective: Identify the personnel involved in performing each system operation task.

Rationale: Knowing which operators or crewmembers are involved in performing each system task is critical to later design of an effective ET component for the system. Identifying the personnel involved, at this point in the analysis, also provides data for later use in judging whether particular activities are appropriate for inclusion in an ET component.

Procedure: Develop unique one-letter codes for each system operator or crewmember position (e.g., C for chief-of-section, L for loader, D for driver, etc.). Obtain a listing of all the unique tasks identified in Step 1.8. Using documentation and SMEs (if needed), examine each task statement, and identify the system operator or crew personnel involved in performing each task. List the appropriate codes to reflect the crewmembers involved in each task. Add these codes to the unique task database records.

Note: If the procedures in Volume 3 of this series (The Role of ET in the Training System Concept) have been performed, job positions by functional area information will have been generated. Use this information to help in this step, if it is available.

Product: Annotations to unique task database records reflecting which personnel are involved in performing each unique task.

SECTION 3

PROCEDURES FOR PHASE TWO: PERFORM DETAILED TASK ANALYSIS

Normally, the procedures presented in Phase Two are not segregated from Phase One procedures. In most ISD analyses, these activities are performed in sequence. In considering ETRs, however, there are two possible cases. The first is the normal case where ET analyses and other analyses to define training system characteristics are carried out together. In this situation, task analysis will always be done, immediately following validation of the task listings.

The second case is when it is necessary to define preliminary ETRs early in the system life cycle--before specific data on the system being assessed are available. ET commonly interacts to a certain extent with prime item system design characteristics. This means that an analysis may be necessary to evaluate the extent that the system will have to be designed with hardware and software features unique to the ET capability. Also, early analyses in support of ET and other training system development may provide insights into effective design of the soldier-machine interface, since task data and the relationships of tasks and soldier functions are considered. The front-end analysis procedures for identifying ETRs have been divided into two separate Phases to accommodate this second case.

If the analysis is being carried out under the second case, Phase Two can be skipped and preliminary ETRs can be defined at the task level. If this is done, a more detailed analysis (with task analysis) to further define ETRs must be carried out concurrent with other training front-end analyses later in system development. It is difficult to specify exact sources for task data for the task analysis procedures very early in the system acquisition cycle (e.g., the concept development stage). If system baselines have been selected or synthesized as part of ECA or HARDMAN, information on operator tasks for the baseline system(s) used for those analyses may be appropriate. Caution is suggested if such an approach is used, however. HARDMAN analyses concentrate on maintenance implications of potential system designs. The soldier-machine interface and task allocations between soldiers and hardware/software components of new systems may differ markedly from those of the system(s) used as HARDMAN baselines.

If human factors engineering (HFE) functional allocations have been performed for the new system, it may be possible to construct an operator baseline composite system based on the functional allocations, and assumptions from existing systems' capabilities. This sort of composite can be used for initial ET requirements and training system

requirements determination analyses. The same caution as above for using data from baseline systems applies to this case. Also, great care must be taken not to accept working baseline composites as drivers of the characteristics of operator tasks, in later stages of the system acquisition process. Later re-definition of the training system and ET requirements must be made based on accurate data from the target system.

An overview of the steps performed in Phase Two is provided graphically in Figure 3. The following subsections present the procedures for task analysis and definition of performance objectives.

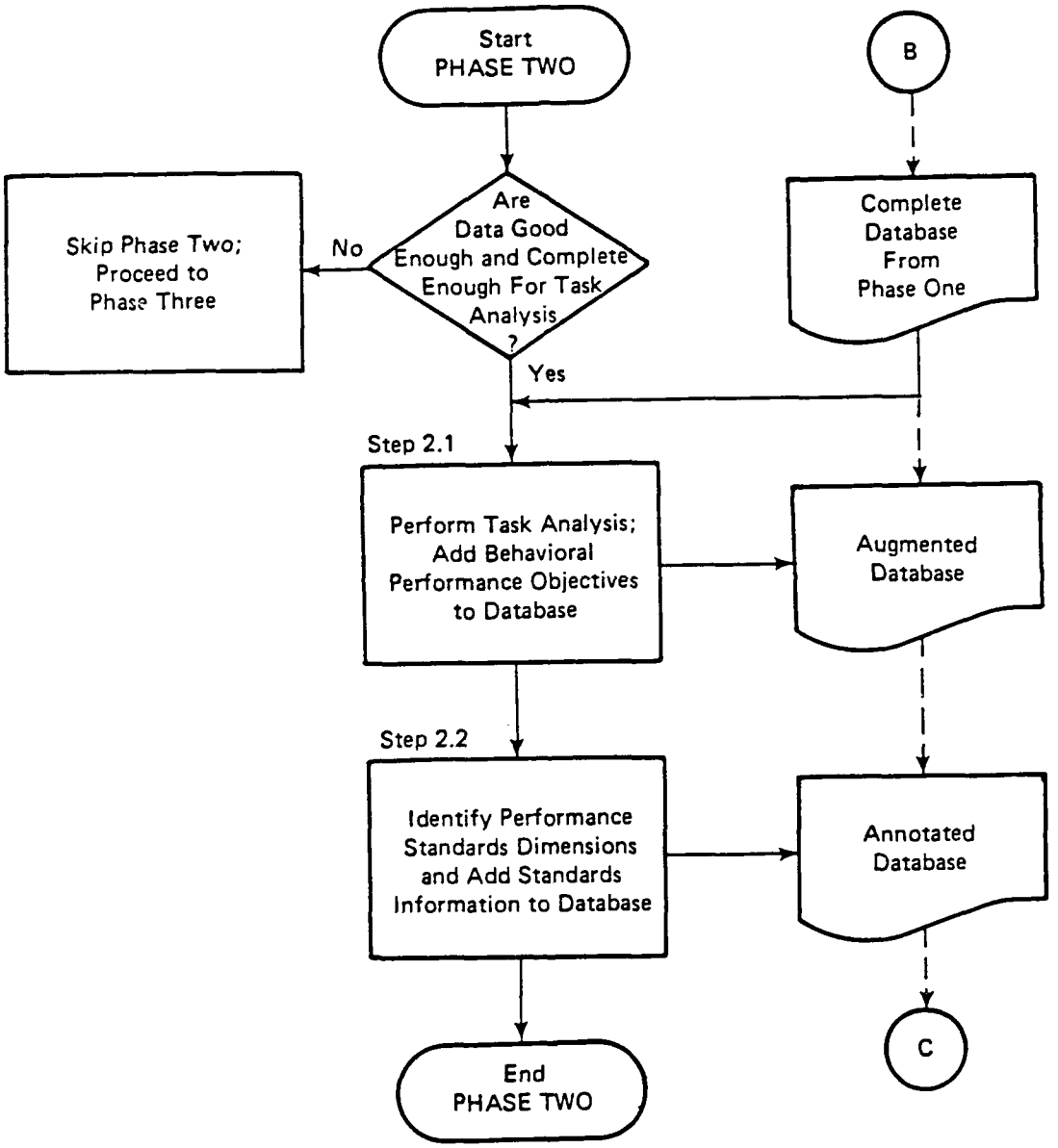
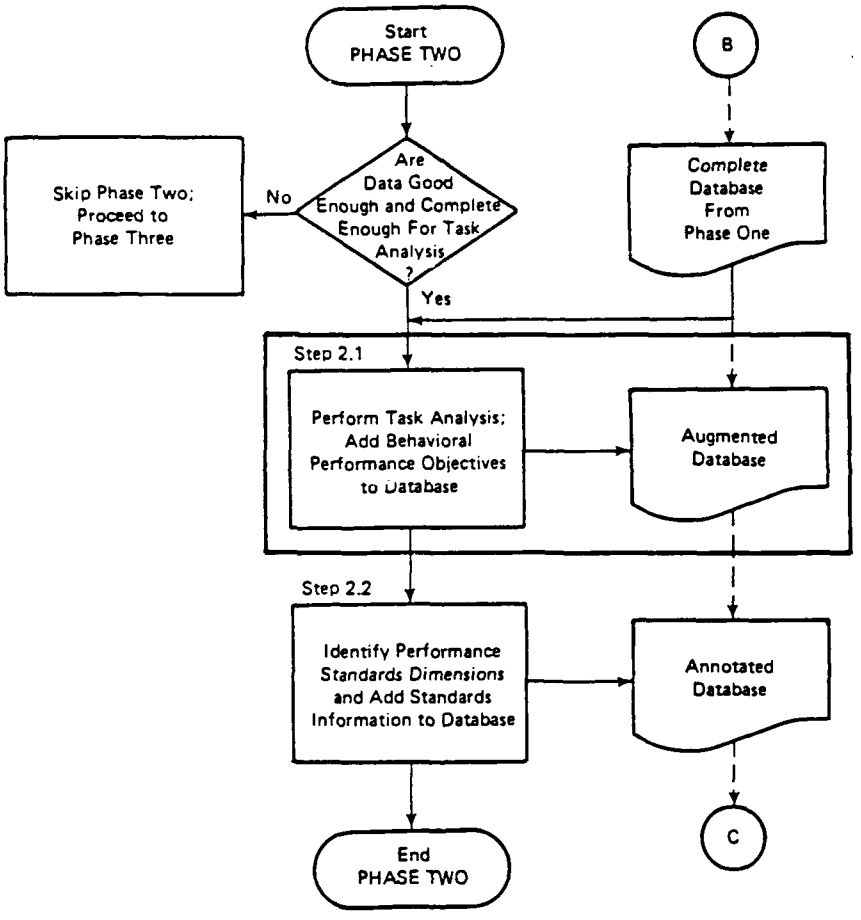


Figure 3. Overview of Phase Two procedures.

Step 2.1: Perform Task Analysis; Add Behavioral Performance Objectives to Database



The use of Form 1 (see Appendix C) for interim data recording is suggested for this step

Step 2.1: Perform Task Analysis; Add Behavioral Performance Objectives to Database

Objective: Analyze each unique operator task to identify the behavioral performance objectives included in the task.

Rationale: In order to design effective task training, it is necessary to know exactly how personnel perform each task for which they are responsible. For developing ET or standalone training devices, it is also necessary to understand specifically how the equipment system and the operator interact. Decisions about the appropriateness and feasibility of providing ET for particular tasks depend partly on the stimuli provided by the equipment system and the environment, and partly on the actions that personnel must perform to respond to or control those stimuli. Thus, each task must be broken down into its behavioral performance components. This analysis performs that breakdown.

Procedure: Using documentation and knowledgeable SMEs (if available), perform the steps described below for each unique task in the database.

1. Divide the task into its component subtasks. This is normally done by identifying each behavioral action performed by the operator in accomplishing the task. Both overt, observable acts and decisions or judgments should be considered to be subtasks or elements of a task. Each performance component identified should be listed, with a hierarchial database code that reflects its position under the task being analyzed. It is suggested that the components for each task be entered into the database as analysis of that task is completed. Source data should also be included in the objective database records.

2. Determine whether all of the necessary decisions in performing the task have been identified as performance components. Clues as to when a decision is required include: (a) when personnel must decide when to perform a procedure, (b) when personnel must determine which of several alternate rules or procedures to use, (c) when personnel must evaluate the adequacy of a procedure or a product, and (d) when personnel must decide when a procedure should be stopped. When a new decision is identified in this evaluation, add it to the components list for that task. The description of the decision must spell out exactly what decisions personnel must make to perform the task in all situations.

3. Determine whether memorization is a significant element of the task. This is true if typical trained personnel would be unable to perform the task as a whole, if they could not remember which task components must be performed, or the order in which they should be performed. This is also true if a person must remember large amounts of reference information to use in the task (for example, communications codes). If job aids, computer prompts, or other memory aids for performing the task are likely to be available, then memorization should not be identified as a significant element of the task. If memorization is a significant component, then memorization must be added to the list of components for a task. The memorization objective should be at the same level of importance as other task components.

4. Determine if too many subtasks or performance components have been identified. Do this by examining the components which have been identified, collectively. There are too many components when:

    a. a component is a lower-level element of any other component listed; or

    b. any component repeats any other component listed; or

    c. any component is not necessary to accomplishment of the task; or

    d. any component is trivial.

    If there are too many components, perform Step 5; otherwise skip Step 5 and go to Step 6.

5. Narrow the list of components to the minimum required to perform the task. Do this in one or more of the following ways:

    a. eliminate components that overlap;

    b. eliminate any component that is part of another component;

    c. eliminate unnecessary components (that are not essential to task performance); or

    d. group trivial components into major logical categories, and designate each category as a single component.

6. Determine whether there are too few components. If, after having mastered all of the performance components listed under a task at this point in the analysis, a person would be unable to perform the overall task after receiving a few simple instructions and a minimal amount of practice, then one or more components has been omitted. If this is true, re-examine the task and the missing critical components to the list of task elements. Add components as required, so that the following statement is true:

Criterion-Level Performance of All Components	+	Some Minimal Instructions & Practice	=	Criterion-Level Performance of the Entire Task.

7. Determine if there are training-related components for the task. Training-related components are behaviors that must be performed in the training environment only, as distinguished from mission-oriented components. This type of component is included to facilitate the learning of mission-related components (for example, touch-and-go landings and stall recovery procedures in flight training; simulation of emergency conditions or malfunctions; etc.). If a need for training-related components is found, add those components to the component list for the task. Training-related components should be identified by a unique code so that they are distinct from mission-related components.

8. Identify conditions of performance for each component. These conditions are of the same sort that were developed for tasks in Phase One, Step 1.7. Use the same procedures and criteria as in Step 1.7 to identify conditions for performance components.

9. Ensure that the performance components under the task are coded to reflect their hierarchial relationship to the task.

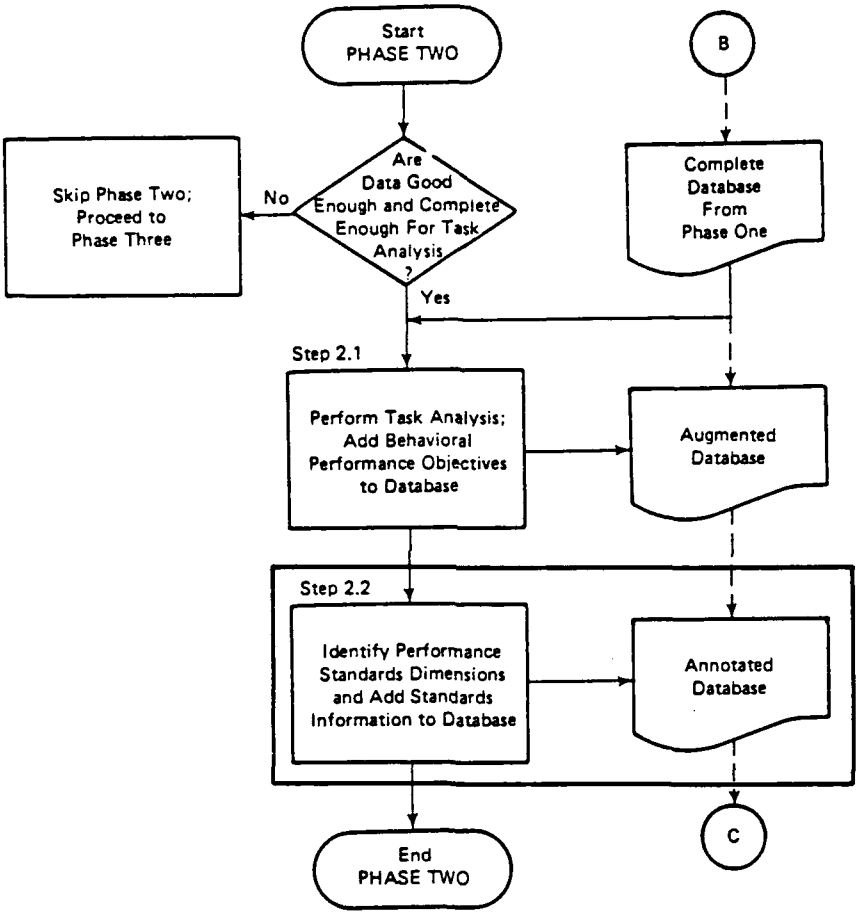
10. Determine whether each performance component is a basic-level behavior (not trivial, but a required element of performance). If all performance components identified under a task are basic-level behaviors (e.g., individual procedural steps, specific decisions, or judgments), then analysis of that task is complete. If there are components which are higher than basic-level behaviors, then analyze those components in turn, until basic-level behaviors have been identified for all aspects of task performance.

Multiple levels of components under a task should be assigned hierarchy codes which reflect their subordination to higher-level components and superordination over lower-level components.

11. Validate the performance objectives database. If, as suggested above, the components of each task are added to the database on completion of the analysis of the task, a final review of the database should be made before moving to the next step. This consists of obtaining an indexed listing of the entire database, and validating that all mission, phase, task, and behavioral performance objective data have been entered correctly, and that the numeric codes of all elements of the database accurately reflect the hierarchial relationships among the elements.

Product: Complete task analysis information, added to the project database.

Step 2.2: Identify Performance Standards Dimensions and Add Standards Information to Database



The generation and use of Form 4 (see Appendix C) for interim data recording is suggested for this step

Step 2.2: Identify Performance Standards Dimensions and Add Standards Information to Database

Objective: Identify the dimensions on which performance of each performance objective will be assessed.

Rationale: One of the major distinguishing advantages that ET affords is its superior ability to measure and assess trainee performance. To be sure that appropriate performance measurement is provided by an ET component, the dimensions of correct performance must be identified. The ability to obtain performance measures on a performance objective is one of the factors you will consider in deciding whether or not to include a task or objective as an ET requirement.

Procedure: For each performance objective in the database, identify the dimension(s) on which the correct performance of the element can be evaluated. At this point, specific criteria such as numeric values of a performance measure are not important. The objective is to identify the measurement variables for the objective. Standards dimensions include (but are not limited to):

1. Time or speed of performance (e.g., completes procedure within x seconds).

2. Accuracy or error rate (e.g., speed, heading deviation, mechanical tolerance, etc.).

3. Safety considerations.

4. Process measures (e.g., sequence of steps in a procedure, correct selection from alternatives, etc.).

5. Product specifications.

Note that particular objectives can have more than one dimension of correct performance. For example, some procedures may be measured both by the sequence of behaviors (process) and the time to complete the procedure.

As dimensions of performance are identified, add descriptions of the dimensions to the database records of the objectives.

Product: Dimensions of correct performance for all objectives identified and added to the database.

SECTION 4

PROCEDURES FOR PHASE THREE: IDENTIFY ETRS AND ASSESS FEASIBILITY AND IMPLEMENTATION APPROACHES

An overview of the steps performed in Phase Three is presented graphically in Figure 4. This Phase of the ETR identification process consists of two major subphases. The first subphase is concerned with nominating performance objectives (at the task or task-component level, depending on whether Phase Two was performed) as ETRs, using two characteristics of objectives: criticality and perishability. Criticality refers to the effect on the outcome of a system's mission if an objective is not performed, or is performed incorrectly. Perishability refers to the extent to which a soldier's ability to perform an objective correctly decays without periodic reinforced practice of the objective. An intermediate step is used in identifying perishability. This step assigns each objective to one of seven categories, based on its psychological properties with respect to retention. The first four steps in Phase Three make up this subphase.

The second subphase is concerned with assessing, in general terms, the ability to implement the nominated ETRs, and identifying candidate approaches to implement each objective identified as suitable for inclusion in an ET component. The final two steps make up this subphase.

NOTE: In evaluating the feasibility of implementing the ETRs, there are a number of decisions that are made which have potential impact on the need to include features or capabilities in the prime system design to effectively implement ET. These needs can sometimes have a significant effect on the design of the prime item system. It is critical that materiel developers be made aware of such needs very early in the system design process, so that these needs can be satisfied by the system design. Also, materiel developers can often provide information about evolving system characteristics and capabilities which influence decisions about the feasibility of implementing objectives in the ET component. It is critical that early and frequent interaction between the ET requirements developer and materiel developers take place to insure that such information is exchanged. It is strongly recommended that an ongoing dialogue with responsible personnel in materiel development for the system (commonly the Project Manager's staff) be established at the beginning of this phase, and that this dialogue be continued throughout the remainder of the ETR development process.

The subsections which follow present procedures for performing the analyses and steps to identify ETRs for a system.

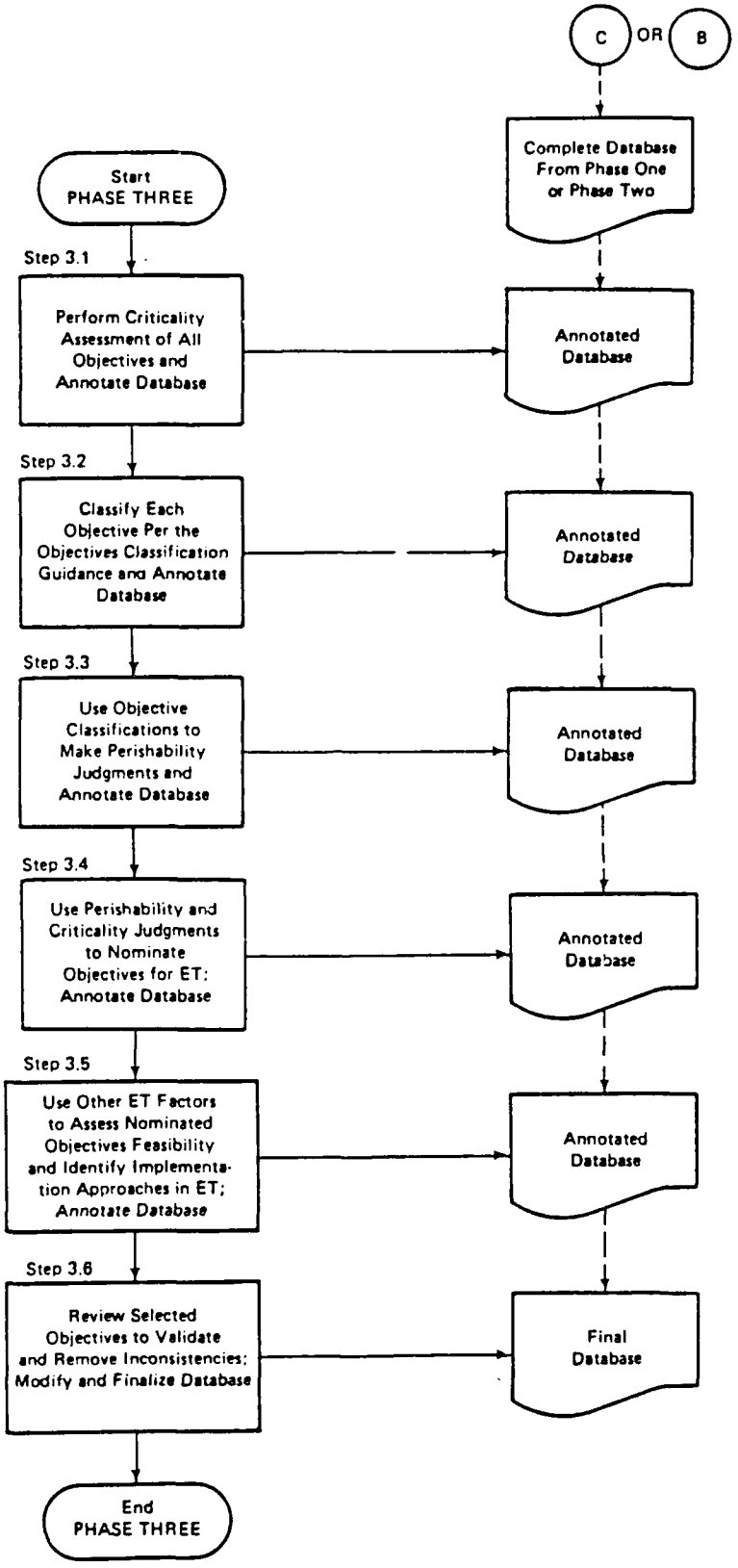
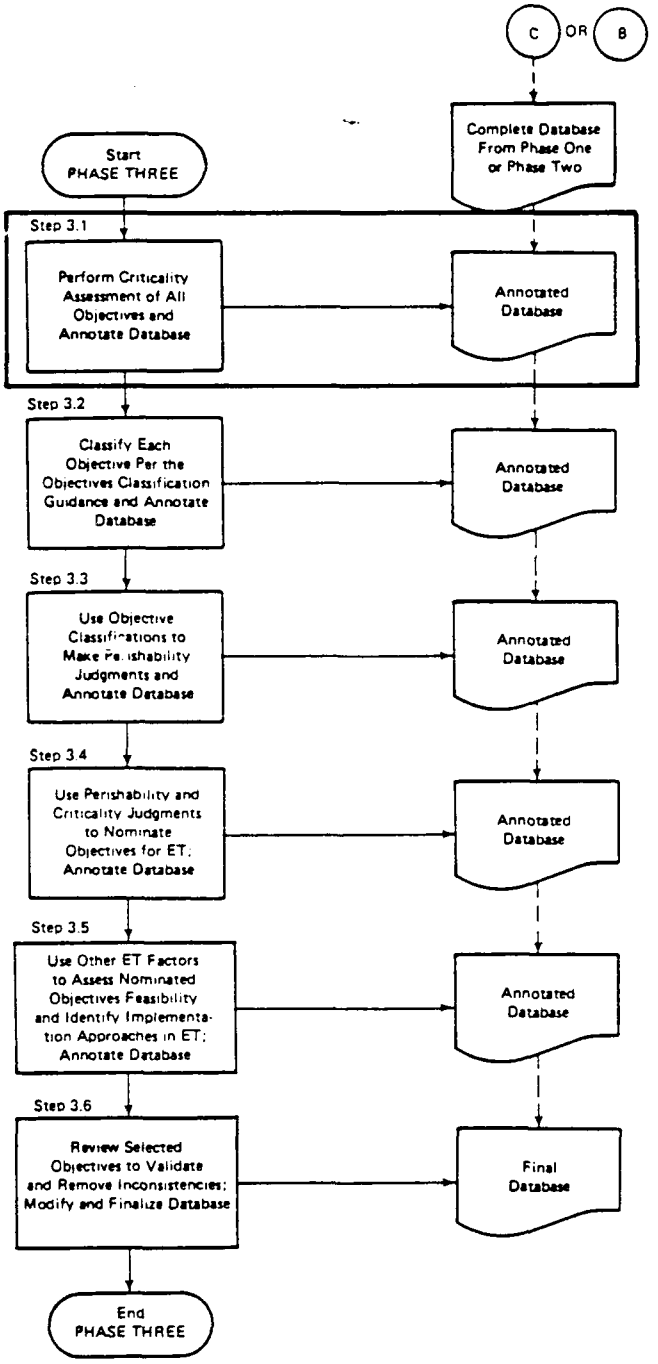


Figure 4. Overview of Phase Three procedures.

Step 3.1: Perform Criticality Assessment of All Objectives and Annotate Database



The generation and use of Form 3 (see Appendix C) for interim data recording is suggested for this step

Step 3.1: Perform Criticality Assessment of All Objectives and Annotate Database

Objective: Classify each performance objective in the database as to its criticality to successful mission accomplishment.

Rationale: Since a principal role of ET will be to provide sustainment training, the objectives that are most important to effective soldier performance must be included in the ETRs. This step identifies the general level of criticality of each performance objective to mission accomplishment.

Procedure: Obtain a listing of all the unique objectives in the project database. For each objective, evaluate the importance of the objective to effective mission accomplishment, according to the guidance provided below. It is critical that SME judgments support the criticality classifications in this step. Documentation generally cannot be relied on to provide the context needed to assess criticality. A panel of two or more SMEs should be used for developing criticality judgments, to ensure that individuals' unique perspectives do not bias the results. If SME support is not available, perform this step anyway. However, if you perform this step without SME support, then the certainty codes (see next page) must be used in conjunction with criticality classifications. In classifying criticality, use the following categories and decision guidance:

HIGH criticality - Failure to perform the objective correctly has a high probability (over 50 percent) of causing negative impact on the success of the mission.

MODERATE criticality - Failure to perform the objective correctly has a moderate probability (25 - 50 percent) of causing negative impact on the success of the mission.

LOW criticality - Failure to perform the objective correctly has a low probability (less than 25 percent) of causing negative impact on the success of the mission.

Assign each objective to one of the three criticality categories. If there is doubt about which of the categories an objective should be assigned to, assign it to the highest criticality category being considered.

As the criticality ratings are made, add a code indicating the level of criticality assigned to each objective to the appropriate database records. Use of the first letters of the three categories (H, M, L) is suggested.

If incomplete information is used to make the criticality decision, SME support is not available, or if there is uncertainty about whether the assigned classification is correct or valid, you may assign a certainty code to the criticality classification. This code can direct your attention or that of others to specific objectives in later iterations of ETR determination procedures. This can help to ensure that the objectives needing specific attention at a later time do receive that attention.

If you use a certainty code, add the code as a second character to the code for criticality classification, according to the following guidance:

1. If you are very certain of the assigned criticality rating (that is, your decision is based on positive knowledge of the task and its importance to the mission), assign a certainty code of 3 to the objective. Example: the code M3 indicates an objective of Moderate criticality, and the criticality judgment is based on positive knowledge about the importance of that objective to the mission.

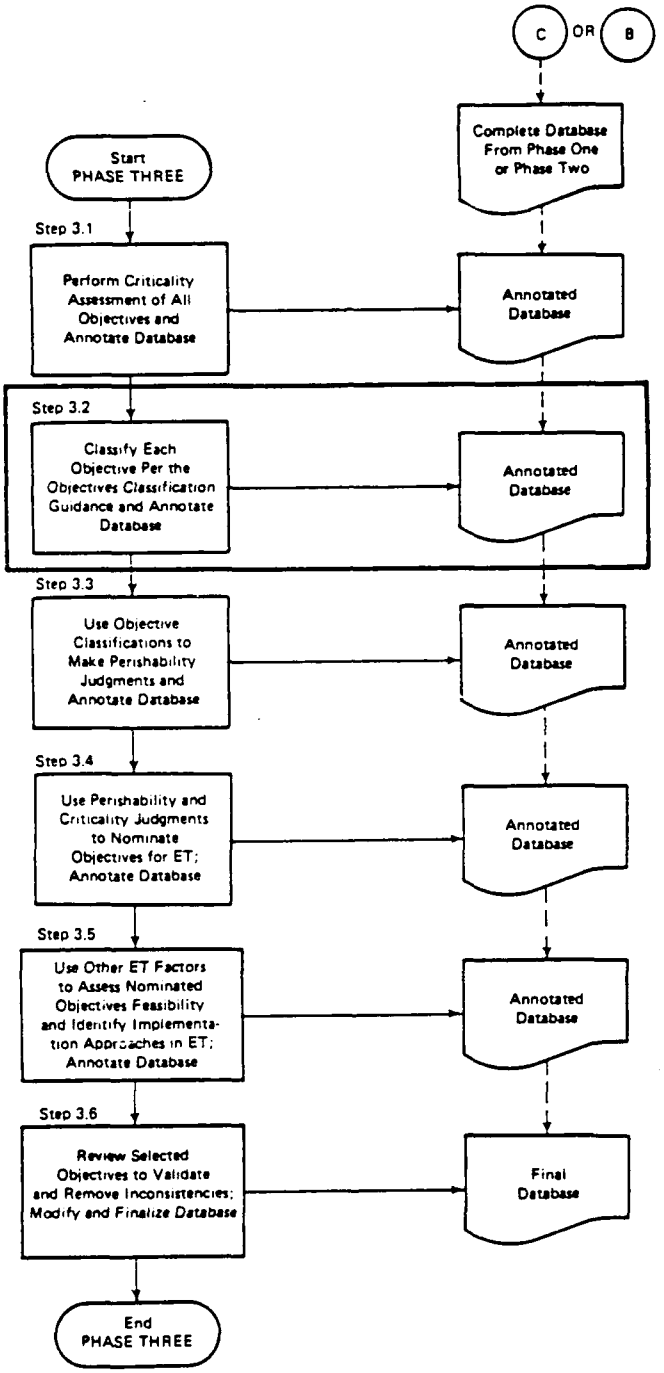
2. If you are moderately certain of the assigned criticality rating (your decision is based on an educated guess, or on SME judgments of unknown reliability), assign a certainty code of 2 to the objective. Example: the H2 indicates a HIGH criticality task, but the judgment is not totally reliable and needs further validation.

3. If you are very uncertain of the assigned criticality rating (the decision is based on a complete guess, or "pulled out of the hip pocket"), assign a certainty code of 1 to the objective. Example: the code H1 indicates a task that you believe to be highly critical, but your judgment is very unreliable and requires SME input to be validated.

If possible, an independent review of the criticality ratings by SMEs not involved in the original ratings development is desirable. This provides independent verification of the criticality assessments. If no independent SME review is possible, the personnel who originally made the criticality judgments should review the criticality data for each objective after it has been entered into the database, as verification.

Product: Criticality judgments of each objective assigned, and appropriately coded in the project database.

Step 3.2: Classify Each Objective Per the Objectives Classification Guidance and Annotate Database



The generation and use of Form 3 (see Appendix C) for interim data recording is suggested for this step

Step 3.2: Classify Each Objective Per the Objectives Classification Guidance and Annotate Database

Objective: Categorize each objective according to its general learning and retention characteristics, to support assessment of the perishability of each objective.

Rationale: Different kinds of skills, knowledge, and abilities decay at different rates when not practiced under conditions where feedback is provided. Seven categories have been defined which have somewhat different performance and retention characteristics that impact on their overall level of perishability. Each objective can be classified into one of the seven categories. In addition to helping in the identification of perishability, these classifications also provide information which is useful in the later design of an ET component for a system. The classifications are performed at this point to support both uses of the data.

NOTE: If desired, this step may be performed at the same time as Step 3.1. The steps are separated because of the necessity of using SME input for Step 3.1. SME input is not required for this step, but (if available) may be useful in clarifying the category into which a particular objective should be placed, if there is doubt about the classification.

Procedure: Obtain a listing of all objectives in the database. Using the objectives classification guidance shown in Table 1, classify each objective into one of the seven categories. Assign the appropriate numeric code shown in the classification guidance table to each objective as it is classified. Enter the classification codes into the database.

NOTE: In some cases, the classification of an objective may appear ambiguous, with the possibility that the objective may fit into more than one classification. In cases like this, assign the objective to the classification with the highest number code being considered. This will avoid "underclassifying" objectives as to their level of perishability, in the next step.

If incomplete information is used to make the objectives categorization decision, or if there is uncertainty about whether the assigned categorization is correct or valid, assign a certainty code to the objective category code. This code can direct your attention or that of others to

Table 1

Objectives Classification Guidance

Class. Code	Task or Objective Type	Description	Examples
6	Integrated Cognitive and Behavioral Skills Performance	Coordinated task performance requiring multiple complex cognitive and/or behavioral skills whose use is governed by rules; may require flexible adaptation to changing conditions of the task or mission, contingency-based application of rules in dynamic situations, or rapid integration and synthesis of sensory information. Highly perishable.	Perform air-to-ground weapons delivery; plan tactical disposition of units based on latest intelligence; lay howitzer using manual methods; coordinate concentration of fires from multiple sources; develop and apply hypotheses about enemy plans; correlate information received from multiple sources; direct air strike.
5	Variable or Contingency Cognitive or Behavioral Skills Performance	Performance of procedures or application of cognitive skills requiring flexible response to a wide variety of contingencies or variations in conditions or data; normally associated with a single task or skill area. Moderately to highly perishable.	Start turbine engine compensating for abnormal conditions; assess and correct weapon stoppage; fault isolate failed jammer subsystem; set alert criteria; edit message text; modify situation map.
4	Rule or Concept Utilization	Simple or complex classification or decision tasks or skills based on applying concepts or rules to available information in given situations. Moderately perishable.	Identify ground vehicle type from seeker video; determine aspect of airborne target; compute meteorological effects on artillery fires; select munitions based on target characteristics; determine message routing.
3	Invariant Procedures	Specific procedures directed toward completing one major task or activity, seldom with contingencies. Performance is essentially linear regardless of length of procedure. Low to moderate perishability.	Perform aircraft preflight inspection; strip, clean, and reassemble M16A2; compose tactical message given contents; load and fire howitzer; prepare mortar round for firing, given charge and fuze data.

Table 1

Objectives Classification Guidance (Concluded)

Class. Code	Task or Objective Type	Description	Examples
2	Basic Cognitive or Behavioral Skill	Basic skills which are concerned with aspects of equipment operation or performance of cognitive tasks; typically prerequisites or components of higher-level skills. Low perishability.	Maintain altitude, airspeed, and heading; load M16A2; drive self-propelled howitzer; set up mine detector; track target using seeking video and joystick; read at 8th grade level; recall password; type command into computer.
1	Knowledges	Facts of any type concerning equipment structure, characteristics, and operation, specific aspects of mission performance, or general (as opposed to situation-specific) data. Low perishability.	State operational range of the AH-64; locate the turret traverse switch; recall maximum allowable service hydraulic pressure; recall reported location of OPFOR elements; state of available intelligence sources.
0	Basic Level Behaviors	Psychomotor or cognitive task components at a lower level than subtasks or procedures (not knowledges) which would not be evaluated independent from the subtasks or procedures of which they are components. NOTE: Basic Level Behaviors are included here to discriminate them from tasks, subtasks, procedures and objectives that are used in determining ETRs. Basic level behaviors may be identified, but should not be considered in ETR determinations.	Set MODE switch to DIAGNOSTICS (component of a checkout procedure); verify landing gear indicator shows DOWN AND LOCKED (component of procedure to lower landing gear); enter function code (portion of a computer operation procedure); find row and column intersections in a table (part of a procedure in data analysis).

specific objectives in later iterations of ETR determination procedures. This can help to ensure that the objectives needing specific attention at a later time do receive that attention.

If you use a certainty code, add the code as a second character to the code for objective categorization, according to the following guidance:

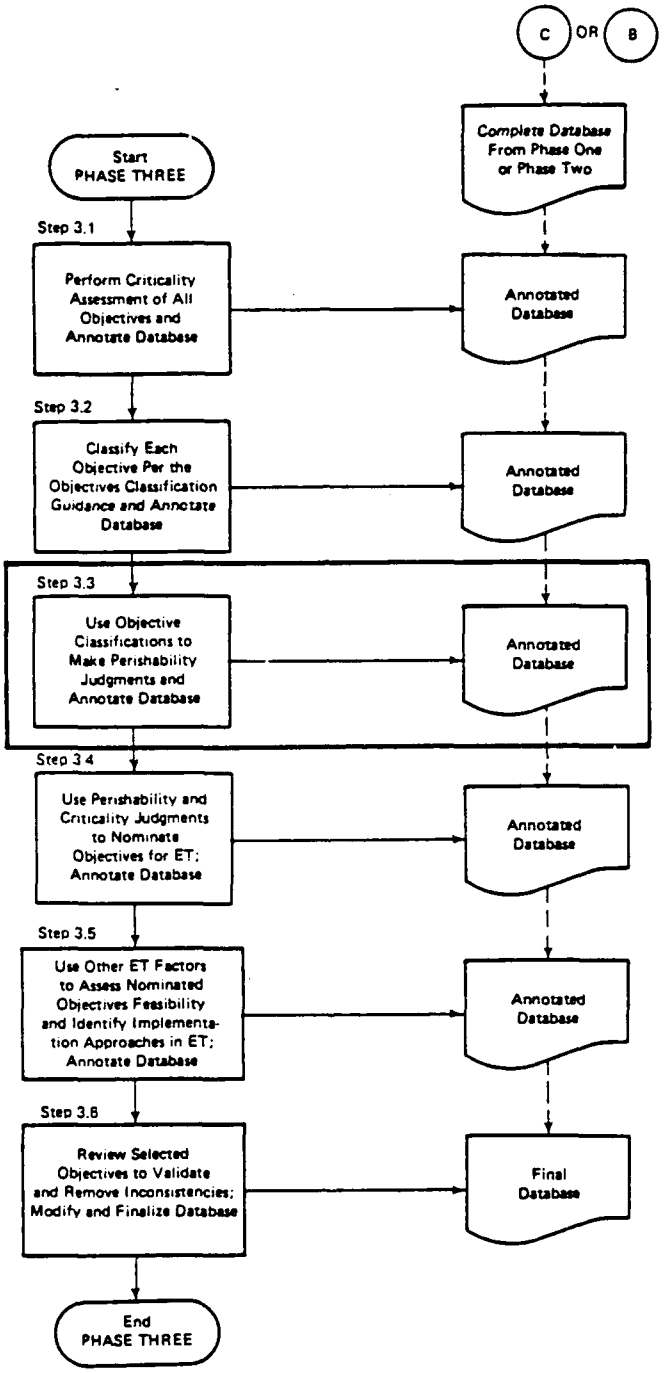
1. If you are very certain of the assigned categorization (that is, your decision is based on positive knowledge of the objective and its characteristics), assign a certainty code of 3 to the objective. Example: the code 53 indicates an objective classified as a Variable or Contingency Cognitive or Behavioral Skills Performance, and the categorization is based on positive knowledge about the characteristics of the objective.

2. If you are moderately certain of the assigned categorization (your decision is based on an educated guess, or on data of unknown reliability), assign a certainty code of 2 to the objective. Example: the code 42 indicates a task categorized as a Rule or Concept Utilization, but the judgment is not totally reliable and needs further validation.

3. If you are very uncertain of the assigned categorization (the decision is based on a complete guess, or "pulled out of the hip pocket"), assign a certainty code of 1 to the objective. Example: the code 61 indicates a task that you believe to be an Integrated Cognitive and Behavioral Skills Performance task, but the judgment is very unreliable (possibly based on very incomplete data), and requires specific data in order to be validated.

Product: Classification codes assigned to all objectives, and entered in the project database.

Step 3.3: Use Objective Classifications to Make Perishability Judgments and Annotate Database



Step 3.3: Use Objective Classifications to Make Perishability Judgments and Annotate Database

Objective: Identify the level of perishability of each objective.

Rationale: Criticality (identified in Step 3.1) and perishability are the two factors used to nominate objectives for inclusion in an ET component.

Procedure: Using the capabilities of the database management software in use, or manually if necessary, examine the objective classifications made in Step 3.2 (field in the database records for objectives). Classify the perishability of each objective, and annotate the database, according to the following rules:

1. An objective is HIGH perishability if it is classified as an Integrated Cognitive and Behavioral Skills Performance, classification code 6. Insert the code H in the database record field for perishability classification.

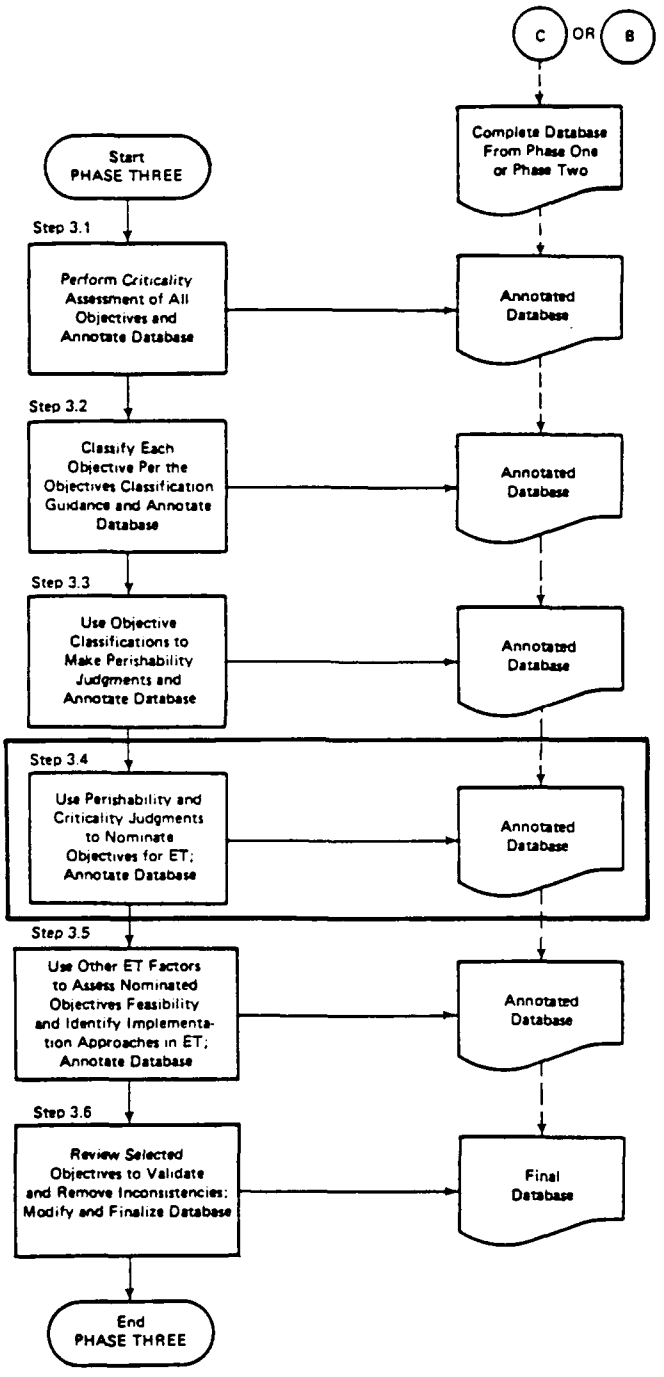
2. An objective is MODERATE perishability if it is classified as a Variable or Contingency Cognitive or Behavioral Skill Performance (classification code 5) or a Rule or Concept Utilization (classification code 4). Insert the code M in the database record field for perishability classification.

3. An objective is LOW perishability if it is classified as an Invariant Procedure (classification code 3), a Basic Cognitive or Behavioral Skill (classification code 2), or a Knowledge (classification code 1). Insert the code L in the database record field for perishability classification.

Basic Level Behaviors (classification code 0) are not rated for perishability, but should be retained in the database, if they have already been identified.

Product: Perishability levels identified for each objective, and appropriate codes added to the project database.

Step 3.4: Use Perishability and Criticality Judgments to Nominate Objectives for ET; Annotate Database



Step 3.4: Use Perishability and Criticality Judgments to Nominate Objectives for ET; Annotate Database

Objective: Identify the objectives in the database which have either High or Moderate criticality or High or Moderate perishability, and designate those objectives as nominated for inclusion in the ETRs.

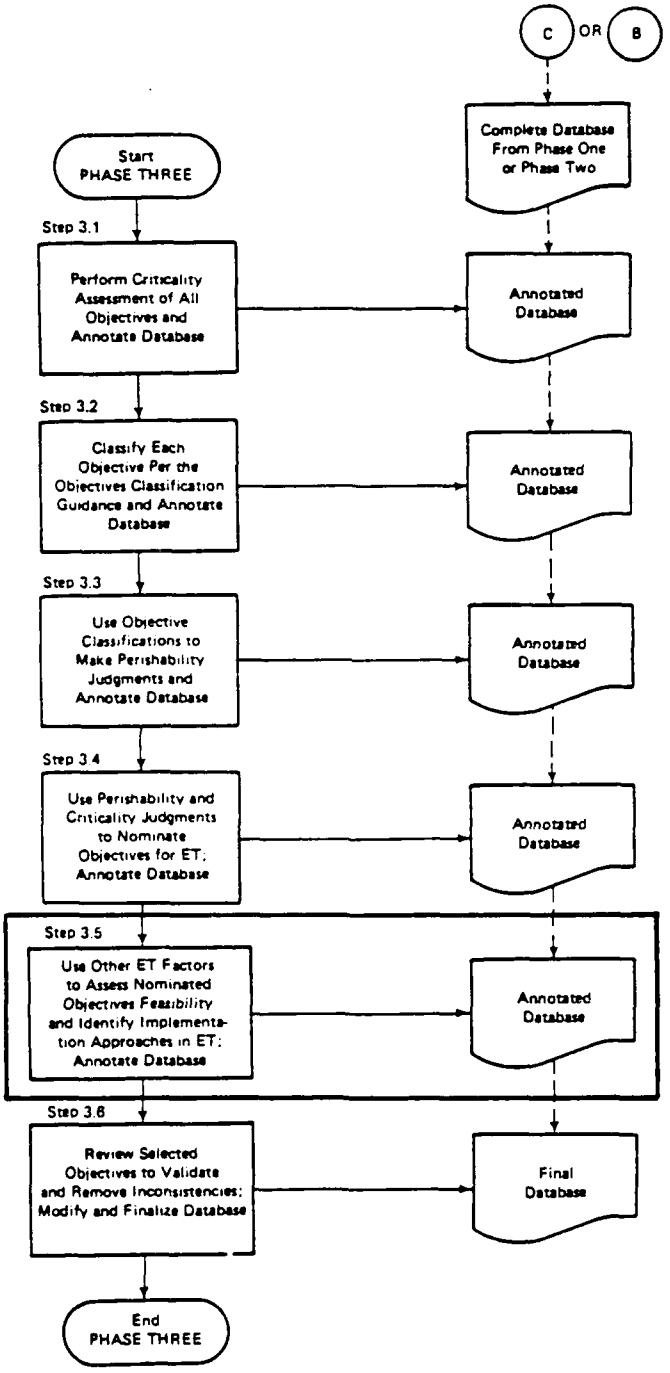
Rationale: High or Moderate objectives and High or Moderate perishability objectives are the best candidates for including in the ETRs. This is due to the fact that many ET components will be used for sustainment training in the unit environment, after initial skills have been acquired elsewhere. To maximize personnel readiness to perform combat missions, critical and perishable skills must be maintained at high levels by sustainment training.

Procedure: Using the capabilities of the database management software in use (or manually, if necessary), examine the perishability and criticality classifications for each objective. Using the following rule, annotate the database record for each objective as to whether the objective is selected as nominated as an ETR, or not.

If the criticality classification code is High or Moderate or if the perishability classification code is High or Moderate, identify the objective as selected as an ETR by placing a Y code in the database record field used for that purpose (normally a "Selected for ET" field). If both the criticality and perishability codes are Low, identify the objective as not selected as an ETR by placing an N code in the database record field.

Product: Identification of each objective as nominated for ET (or not) and appropriate annotation of the records of the project database.

Step 3.5: Use Other ET Factors to Assess Nominated Objectives Feasibility and Identify Implementation Approaches in ET; Annotate Database



The generation and use of Form 5 (see Appendix C) for interim data recording is suggested for this step

Step 3.5: Use Other ET Factors to Assess Nominated Objectives Feasibility and Identify Implementation Approaches in ET; Annotate Database

Objective: Perform an initial assessment of the feasibility of implementing each objective nominated as an ETR, and identify potentially suitable approaches to implementation of the ETRs.

Rationale: The ETR nomination performed in Step 3.4 considers only perishability and criticality, and does not deal with implementing the nominated ETRs. This step provides an initial assessment of each of the ETR-nominated objectives, from the viewpoint of potential requirements to include the objective in an ET component. The analysis here is done at a gross level in an attempt to exclude obviously unsuitable objectives. This also allows you to make an initial estimate of the proportion of ETR-nominated objectives that will be straightforward to implement, and those that will be difficult to implement.

These analyses assume that general characteristics of the soldier-machine interface(s) of the target system can be at least estimated. That is, a concept of how the soldier interacts with the target system, and with the environment in which the target system will operate, should be available. For example, if most input is provided to a soldier through a video display, or if the soldier sees direct-view or optically relayed images of the visual environment outside the system, these are important characteristics of the way task stimuli are presented by the system. The ways the operator controls the system are also important characteristics that should be considered. If discrete actions (like moving a joystick or pressing keys) performed by a soldier can be sensed by the ET software, it is likely that sensing operator actions can be relatively straightforward. On the other hand, if the result of an operator task is a decision or spoken language, it may be impossible for the ET software to sense the outcome.

If it is possible to have at least a gross concept of the ways the soldier interacts with the system, this step should be accomplished. Sometimes, early in the acquisition process, this kind of information simply is not available. If a concept of the soldier-machine interface is not available, then this step may be bypassed. If this step is bypassed, this should be clearly stated when reporting the ET requirements identified by this process. Assessment of the feasibility of implementing the various ETRs will have to be made during preliminary design of the ET component, if it is not done here.

Procedures: Obtain a listing from the database of each objective nominated as an ETR in Step 3.4. This listing must include the complete objective statement, and the conditions and (if Phase Two has been performed) standards of performance for each objective. This information will be required to make some of the judgments in the substeps that follow. An overview of the implementation and feasibility decision algorithm that is used to address the tasks and objectives is shown in Figure 5. Study the algorithm until you are comfortable that you understand its structure and the decisions that must be made to go through the algorithm. After you are familiar with the algorithm, follow the procedures below.

NOTE: It is often useful to deal with these decisions on a global basis before performing detailed analyses at the task or objective level. In some cases, it may not be necessary to apply all of the decision questions, if you decide that the characteristics of the target system or the tasks under consideration support a global decision about some implementation factors.

For example, if you are dealing with a target system where personnel only interact with a computer terminal or a console, it is probably not necessary to consider whether providing visual or auditory simulation of the non-equipment environment is needed for effective training. In such a case, the questions dealing with visual and auditory environment simulation requirements could be omitted.

If you can make this kind of global decision, you can shorten the analysis process so that all questions do not have to be asked for all objectives which are nominated as possible ETRs. Before you "tailor" these procedures by omitting decision questions, however, review the nominated ETRs and the characteristics of the target system, and ensure that questions that you consider omitting are not relevant to providing effective training.

If you are able to "tailor" the decision algorithm, you will be able to omit some of the steps below. But, you should study all of the steps before omitting any of them so that you will ask the correct questions in your "tailored" procedures. If you do not "tailor" the decision algorithm, follow the exact sequence of questions and decisions shown below, for each objective nominated as a possible ETR.

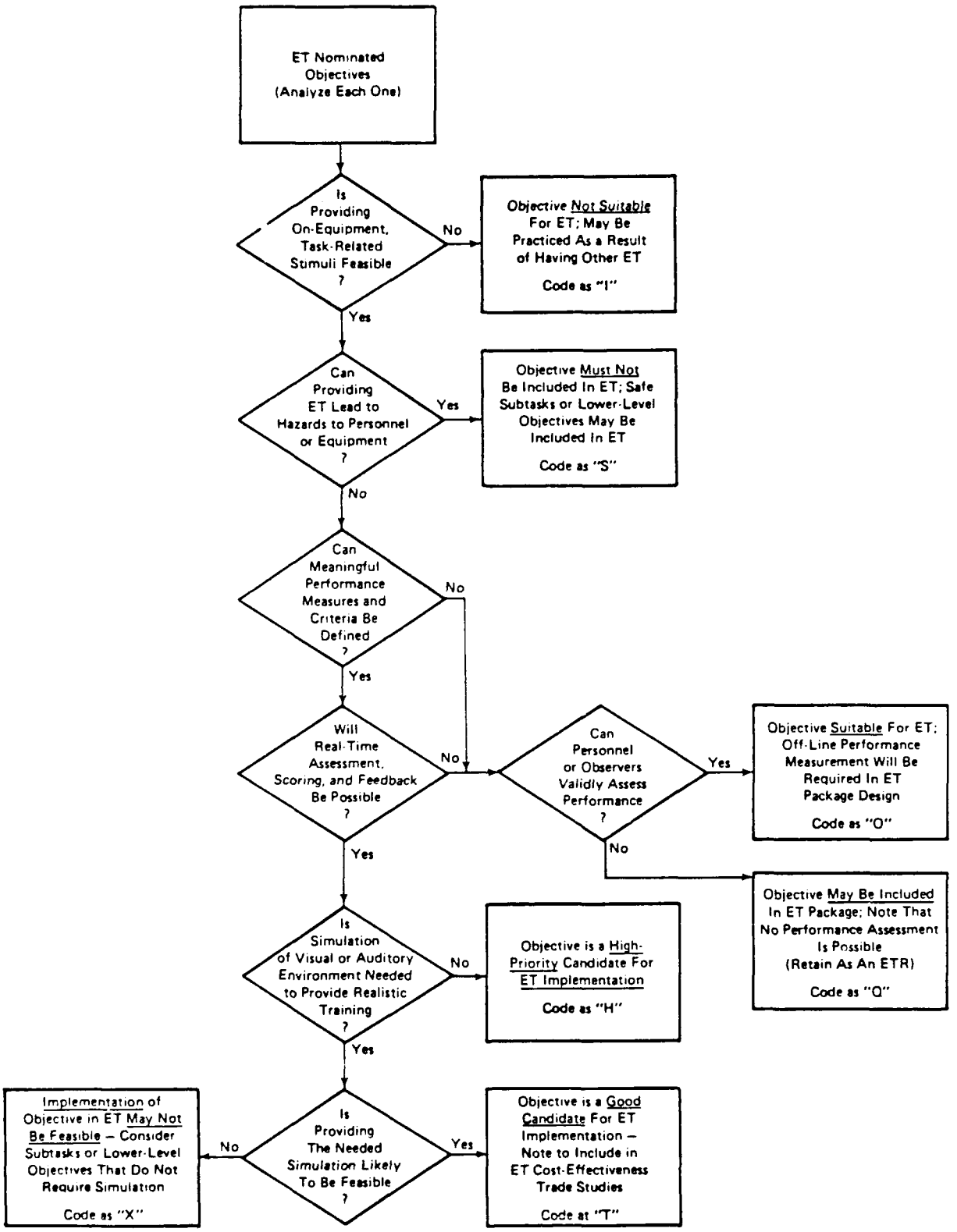


Figure 5. Overview of the algorithm for evaluating implementation approaches for ET requirements.

Substep A - Decide whether providing the stimuli needed to perform the objective on the target system equipment is feasible. At this point, do not consider stimuli that a soldier may get from other sources than the system equipment. This will be considered at a later step in the algorithm. For example, if most information is presented to soldiers by means of visual display units (VDUs), implementing ET will probably be fairly easy. On the other hand, if most information comes from "round dial" displays, ET may be somewhat be harder to implement. A general guideline to use is that anything in terms of system displays that is presented or controlled by a computer or microprocessor can probably be implemented fairly easily. This includes such things as lighted pushbuttons or function switches, in addition to VDU displays, etc.

NOTE: If this analysis is being done in early phases of system development (e.g., concept formulation), it may be possible to provide additional capabilities to implement an ET component. Do not assume that stimuli for an objective cannot be implemented without some positive evidence that this is true. It is recommended that materiel developers be consulted throughout the process of determining whether it is feasible to implement aspects of an ET component on the system.

If you judge that it is feasible to present the stimuli needed to perform the objective, then go on to Substep B below.

If you decide that it is not feasible to present the equipment stimuli, you have decided that the objective is not feasible to include in ET. When you make this decision, annotate the objective "ET Feasibility Judgment" field in the appropriate database record with the code "I." This indicates that the objective is judged infeasible for implementation.

Substep B - Decide whether providing the objective as part of the ET component could result in hazards to personnel or the possibility of damaging the system or other equipment.

To make this judgment, you will need to imagine or form a concept about how the system might be used in training, and how including an objective in ET could be hazardous to personnel or equipment. Consider the conditions under which the objective is performed in developing this concept. For example, if you are considering an aviation system, and providing visual stimuli on a heads-up display to train an objective in-flight would be required, consider whether the stimuli could obscure a crewmember's ability

to see safety-related cues in the outside world. A general guideline that can be used is: if the system is in motion during an objective, or the objective causes gross physical movement of the equipment or its parts, it is possible that a hazard could be created if the objective were included in ET. Another useful guideline is: if an objective requires live fire of weapons or handling of live ordnance, there could be a safety compromise if the objective is included in ET. Consultation with materiel developers may help to develop concepts about implementation safety.

The guidelines above should not be thought of as ruling out simulation of damage to the system as part of an embedded training exercise. For example, it may be a useful form of feedback to provide simulated indications that erroneous operator actions have caused the system to be damaged, or in an abnormal state. Actual damage to the system would, of course, not take place. Also, simulated malfunction indications might be used to provide stimuli for maintenance fault isolation tasks.

If you judge that the possibility of safety compromise does not exist for an objective, or that safety compromise is unlikely, then go on to Substep C below.

If you judge that safety compromise is a significant possibility if an objective is included in ET, then you have decided that the objective must not be included in ET. When you make this decision, annotate the objective "ET Feasibility Judgment" field in the appropriate database record with the code "S." This indicates that the objective has been excluded from further consideration for ET because of the likelihood of safety compromise.

Substep C - Decide whether meaningful performance measures and criteria can be defined for the objective. In this case, meaningful refers to the ability to identify the way a soldier performs an objective, by sensing the soldier's actions or identifying specific outcomes of the soldier's behavior. Such actions or outcomes reflect how well the soldier has performed. When making this decision, you should consider more than just gross-scale "tactical" measures of performance, such as the number of targets killed versus the number presented. A useful guideline in this decision is: if it is possible to sense the actions the soldier takes in performing an objective, and relate those actions to the outcome of the soldier's performance, then there is a good chance that meaningful performance measures can be derived. You should consider that any

action performed by a soldier which causes a physical change in the controls the soldier interacts with (e.g., changing the position of a switch, moving a joystick, typing in a command on a keyboard) could be sensed by an ET component. Response sensing serves as signals for evaluating performance or adaptively modifying the training situation. As in the safety compromise judgment in Substep B, it may be useful to develop a "scenario" of how a soldier would perform the objective, and what equipment would be involved.

If you judge that meaningful performance measures can be derived by sensing and interpreting operators' actions, then proceed on to Substep D.

If you decide that meaningful performance measures cannot be derived by sensing and interpreting operators' actions, then proceed to Substep E.

Substep D - Decide whether it is feasible to perform assessment, scoring, and real-time feedback of performance related to the objective. Performance assessment and feed back are extremely valuable features of an ET component, so this decision can be crucial. Although the decision is crucial, the information needed to make the decision is often not available.

The actual determination as to whether it will be feasible to provide capabilities for assessment, scoring, and feedback of trainee performance will rest with overall system capabilities. In case of doubt as to whether such capabilities will be made available, it is strongly suggested that discussions with the system materiel developers be held. If there is a potential need to make special provision for these training support capabilities, requirements for the system can sometimes be augmented to provide the needed capabilities. However, it is extremely important to make such inputs to materiel developers early in the system acquisition process, so that expensive design changes later in the development cycle can be avoided.

It appears, in most cases, that the limiting factor on this decision is the amount of computer processing capability and storage available through the system or via the ET component. It is perhaps wise to make this decision on a global basis. The question to ask is: will there be processing and storage capacity available to support assessment, scoring, and feedback in general? Frequently, even such a high-level decision will be impossible. If it is not possible to make a decision at this point at either an objective level or a global level, skip this decision, and assume that all desirable assessment, performance scoring, and feedback capabilities are possible. However,

if this decision is made, do not neglect to perform Substep E for objectives for which developing performance measures and criteria is not possible. Also, note that this assumption was made.

If you judge that performance assessment, scoring, and feedback are possible for specific objectives, proceed to Substep F.

If you have made a general judgment that performance assessment, scoring, and feedback are possible through the equipment or the ET component at large, also proceed to Substep F.

If you judge that performance assessment, scoring, and feedback are NOT possible for specific objectives, proceed to Substep E.

Substep E - For objectives where either: (a) meaningful performance measures and criteria cannot be derived by measuring soldiers' actions; or (b) performance assessment, scoring, and feedback are not possible through the ET component for a particular objective, decide whether the soldiers performing the objective, or an over-the-shoulder observer or instructor, can provide effective performance assessment and feedback.

Since ET will commonly be used for sustainment training, it is possible that soldiers may be proficient enough to evaluate their own performance and diagnose their own errors, in some cases. Also, if the ET component cannot provide performance assessment, scoring, and feedback, it may be possible to provide an instructor or observer to do so.

Two guidelines are useful in making this decision. In the case where you are considering whether the soldiers themselves can assess their own performance, decide whether: (a) in a crew situation, some crewmembers are likely to be more proficient or senior than others; or (b) in any situation, the overall level of proficiency and expertise of task performers is likely to be high. If either of these considerations is true, self-assessment potential is high, and it is probably feasible to allow crewmembers or individual soldiers to assess their own performance in an ET environment.

In the case where you are considering the possibility of over-the-shoulder evaluation, consider whether it is possible for an evaluator to observe exactly what situations and stimuli are presented to the trainee, and what the trainee's actions and behaviors are. If this is judged

to be the case, then the probability of successful over-the-shoulder evaluation is high. Whether it is feasible to provide over-the-shoulder evaluation from other standpoints (such as personnel requirements or cost) should not be considered at this time.

If you judge that self-assessment or over-the-shoulder evaluation is reasonably feasible, you have identified the objective as suitable for ET with off-line performance measurement. When you make this decision, annotate the objective "ET Feasibility Judgment" field in the appropriate database record with the code "O." This indicates that the objective has been judged feasible for ET implementation with Off-line performance measurement.

If you judge that self-assessment or over-the-shoulder evaluations are not possible for a given objective, the value of including the objective in an ET component is questionable. If this decision is reached, the objective will be retained in the ETRs for the time being, but will be coded specifically to reflect that performance measurement is not considered possible. When you make this decision, annotate the objective "ET Feasibility Judgment" field in the appropriate database record with the code "Q." This indicates that the objective is Questionable from the viewpoint of performance measurement.

Substep F - Decide whether the objective requires simulation of any aspects of the visual or auditory environment external to the equipment to provide all needed stimuli to accomplish the task or objective. This includes such stimuli as out-the-window views of the environment, images from remote or indirect sources such as cameras or infrared sensors, weapons firing sounds or visual impact signatures, or any other completely external stimuli. In general, such stimuli are difficult and costly to provide, so the need for them must be carefully considered. However, if static images are required, it is more feasible and less costly to provide them than if dynamic images are required.

In making this judgment, knowledge of the stimuli which are present in the actual task performance situation is critical. Use the conditions of performance data provided for each objective to support this decision. "Scenarios" of how the objective is performed, and how the soldier interacts with the equipment and the performance environment may be useful in making this decision. In general, if a soldier receives stimuli from a source outside the equipment itself which are critical to objective performance,

then it will probably be necessary to simulate those stimuli in the ET component.

If you judge it is necessary to provide visual or auditory environment stimuli in order to present the objective to the trainee, proceed on to Substep G.

If it is not necessary to provide visual or auditory environment stimuli, then you have finished with the decisions for this objective. When you make this decision, annotate the objective "ET Feasibility Judgment" field in the appropriate database record with the code "H." This indicates that the objective is a High-priority candidate for implementation in the ET component, and is retained as an ETR.

Substep G - Decide whether providing the needed visual or auditory stimuli is likely to be feasible. There are two aspects of the stimuli and the objective situation to consider in making this decision. The first is whether a static representation of the visual environment can be used, or whether a dynamic representation is required. (Auditory stimuli cannot be static.) If visual motion of any portion of the external environment has to be simulated, then a dynamic representation is required. If a completely static representation of the "outside visual world" will do, then it is probably feasible to provide that presentation.

As with assessment, scoring, and feedback capabilities, the implementation of visual and auditory simulation requirements interacts strongly with system characteristics. If visual and auditory stimulation requirements are identified as necessary for implementing ET, it is strongly suggested that these requirements be made known to materiel developers as early as possible. If early identification of these requirements is made, it may be feasible to augment system capabilities to make presentation of such stimuli possible, or to provide for these capabilities in the system design. The decision to implement these capabilities must be coordinated with the materiel developers, however. Providing simulation capabilities to support ET may have significant impacts on system design, and knowledge of possible requirements for these capabilities is essential in the design trade-off process for the system. Decisions about including these capabilities should be made jointly with materiel developers.

If a dynamic representation of either auditory or visual aspects of the external environment is required, then the required level of fidelity of presentation must be

considered in judging feasibility. If a soldier will have to use the representation to make fine judgments about the characteristics or dynamic nature of what is presented, then a high-fidelity presentation will be required. Examples include discriminating subtle visual characteristics to classify targets by their visual signatures, and judging by sound how many rounds have been fired from an automatic weapon.

If the soldier will only be required to make gross judgments about the presence or absence of major features of the environment representation, then a lower level of fidelity will be required. Examples include judging whether artillery aiming stakes are lined up in a sight reticle, and discriminating the presence of an auditory warning tone from background noise.

Visual and auditory fidelity decisions can be difficult, and the examples above are extremes; there are many points between them on the fidelity continuum. In general, consider the fineness of judgment about the external environment that the soldier will have to make, given what is presented. The finer the judgment, in general, the higher the fidelity required in the stimulus presentation, and the lower the feasibility of providing the needed stimuli will be (other things being equal).

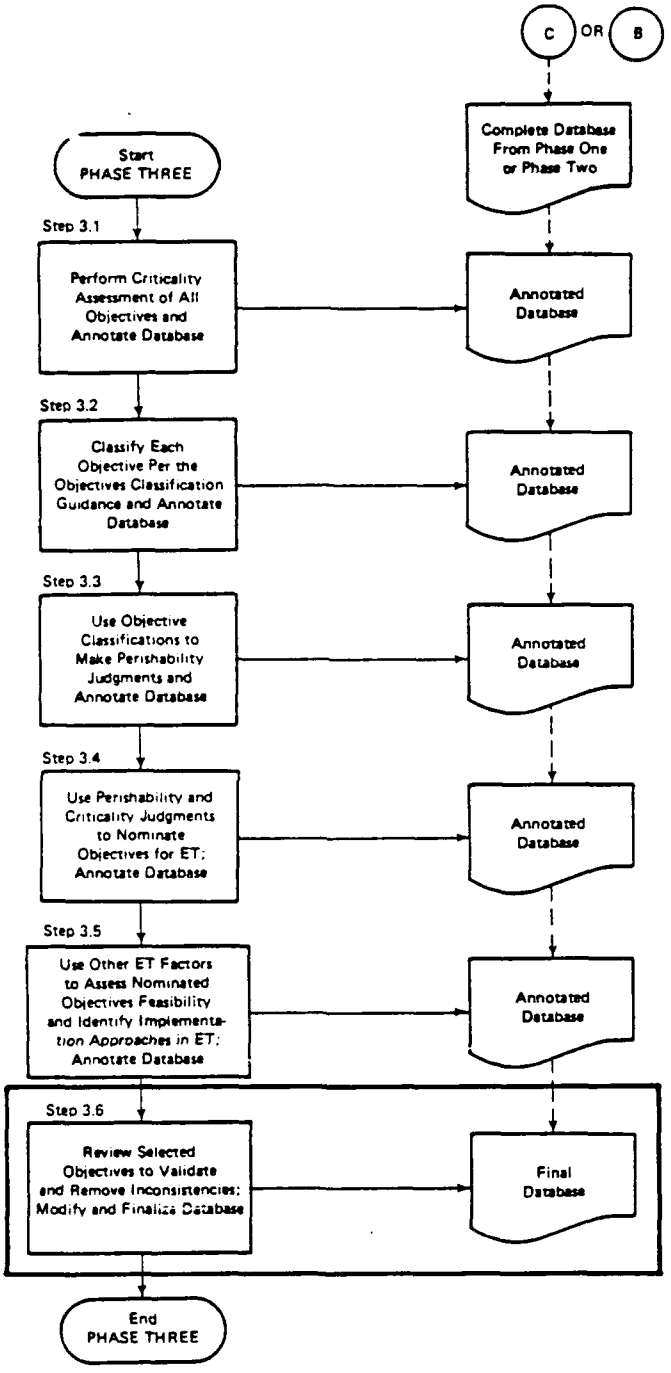
If you decide that it is <u>at least marginally feasible</u> to consider including the needed level of fidelity in simulating the external environment, then you have classified the objective being considered as a good candidate for ET. It will be retained in the ETR. When you make this decision, annotate the objective "ET Feasibility Judgment" field in the appropriate database record with the code "T." This indicates that the objective will require simulation of exTernal auditory or visual stimuli, but that providing that simulation is considered feasible.

If you decide that <u>it is probably not feasible to include the needed level of simulation fidelity</u>, then you have <u>contingently excluded</u> the objective being considered <u>from the ETRs</u>. Some subtasks or lower-level objectives that are subordinate to an objective may still be good candidates for inclusion, however, and should be carefully considered, in turn. When you make this decision, annotate the objective "ET Feasibility Judgment" field in the appropriate database record with the code "X." This indicates that the objective has been eXcluded from further consideration for ET because providing the needed external environment stimuli is probably not feasible.

At this point, all decisions in this step about the objective under consideration are complete. Proceed to analyze the next objective on the listing.

Product: ET feasibility and implementation approach judgments, coded and added to the project database.

Step 3.6: Review Selected Objectives to Validate and Remove Inconsistencies; Modify and Finalize Database



The generation and use of Form 6 (see Appendix C) is recommended

Step 3.6: Review Selected Objectives to Validate and Remove Inconsistencies; Modify and Finalize Database

Objective: Identify ETR selection anomalies among the objectives, correct the anomalies, and validate the project database.

Rationale: In some cases, the strict nomination criteria for ETRs (perishability and criticality) will not nominate all of the objectives which are above a nominated lower-level objective. This is a mistake: if a lower-level objective is nominated as an ETR, then all of the objectives superior to it in the hierarchy should be nominated, as well. A lower-level component being validly nominated as an ETR should result in all of the components above it in the hierarchy being nominated.

The reverse case, where a higher-level objective is nominated, but lower-level objectives are not nominated, is not a cause for concern. A perishable or critical aspect of performance can have some non-perishable or non-critical components.

This step will identify cases where low-level objectives are nominated, but elements superior to them in the hierarchy are not. Then, the hierarchy will be examined to identify the source of the problem and it will be corrected.

Procedure: Obtain a listing of the entire database, indexed by hierarchy codes. As a minimum, codes, objective statements, criticality judgments, objectives classifications, perishability judgments, ET nomination codes, and feasibility codes should be included in this listing. Then, examine the objectives hierarchy in detail, and identify all cases where lower-level objectives are nominated as ETRs and higher-level elements above them in the hierarchy are not nominated.

For each case where this occurs, examine the criticality and perishability judgments and the objectives classification for the lower-level objective first. Determine if a mistake has been made in assigning codes for any of these data items. Also, determine if wrong judgments may have led to the assignment of the erroneous codes.

If it turns out that the only error is in coding or judgment of one or more factors for the lower-level objective, simply correct the appropriate items in the

database. This is the most likely case if the preceding steps have been done conscientiously.

Otherwise, it will be necessary to examine each of the objectives superior to the lower-level objective, determine where erroneous judgments have been made or wrong database codes have been inserted, and correct all problems that are found.

As the database is examined, also look for minor errors such as misspellings and missing information. Correct any such errors, where possible. The database will be used to support the design of the ET component. Thus, it should be comprehensive, accurate, and complete at the end of this step.

Product: The final analysis database, reflecting the performance objectives hierarchy, all judgments made in the ETR definition process, the nominated ETRs, and tne implementation judgments.

SECTION 5

PHASE FOUR: FINAL DOCUMENTATION

Objectives

The ETRs feed three subsequent processes. First, the output from the ETR analyses is used in the ET design process[1], where the form and content of ET are structured. Second, the ETRs have strong implications for early hardware and software decisions that are part of the design process[2] for the prime equipment in which training is to be embedded. Third, courseware and training development processes will use the database developed in identifying ETRs to develop the training. The purpose of this section is to structure the outputs from the ETR process so that they are maximally useful to support these processes. While this section does not prescribe exact procedures for generating outputs, a general structure is provided. This structure is reflected in Figure 6.

Rationale

The final database resulting from the ETR analyses contains a large amount of data; in the next subsection 17 different data elements are listed. These data elements are either descriptions or multiple logical entries. The most useful way to present most of this information is on a task-by-task basis. If one were to create a listing that has several columns, the information about each objective might be seen side-by-side. The sheer amount and number of different data items pertinent to an objective make the concurrent presentation of all of the data items impossible. It is necessary to break this information down into coherent smaller reports so that each user sees relevant information quickly, and can perform rapid analyses of the data to facilitate decision making.

The purpose of this section is to specify formats for a set of data reports that present this information to different users, in a

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[1]See: Implementing Embedded Training (ET): Volume 5 of 10: Designing the ET Component

[2]See: Implementing Embedded Training (ET): Volume 6 of 10: Integrating ET with the Prime System

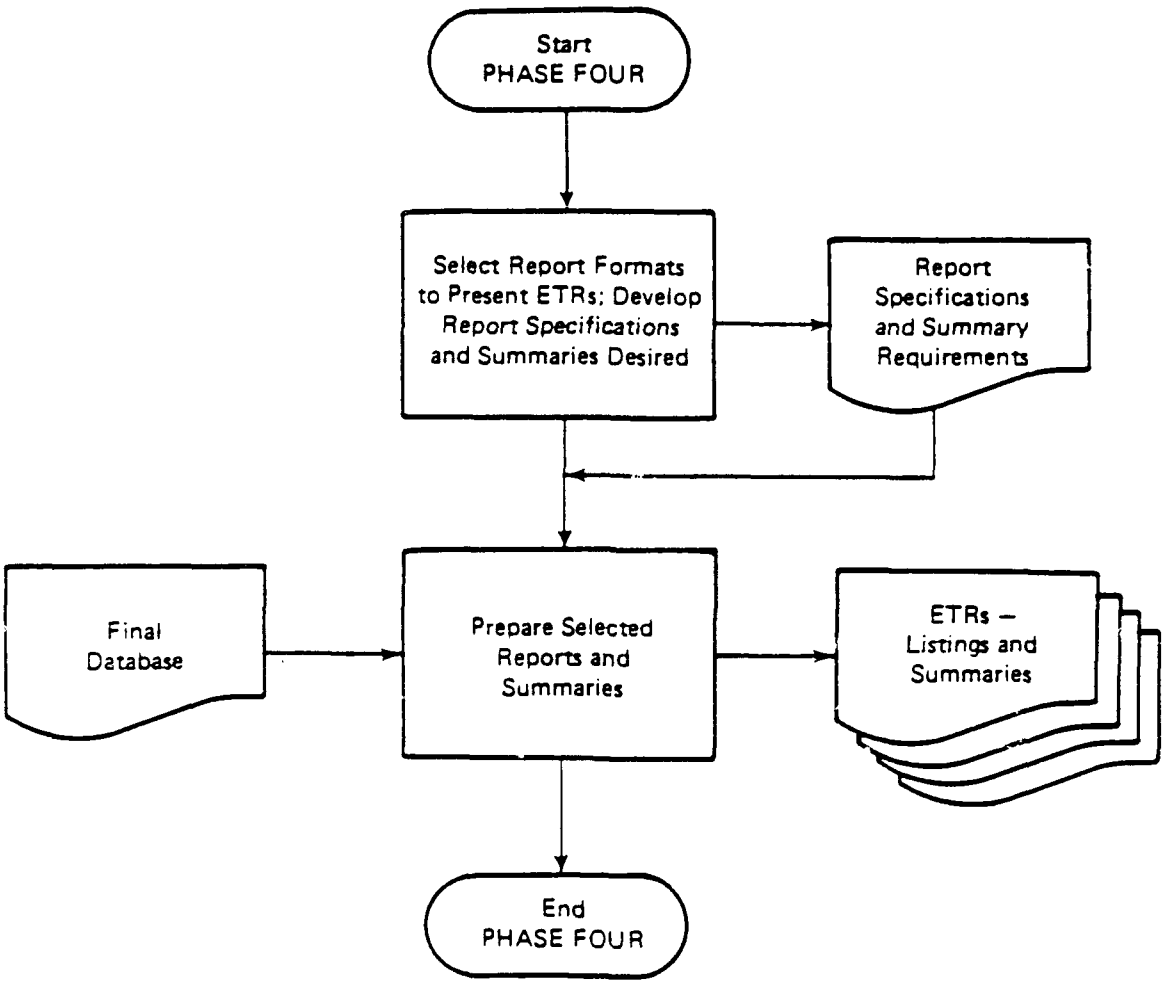

Figure 6. Overview of procedures to prepare ET requirement documentation.

usable way. Some of the information is presented more than once, because different processes require both common information and unique information.

Procedure

Data items in each objective record come from the analyses performed in Phases One through Three. The data to be formatted and organized are in 3 categories: (1) task analysis data, (2) ET development data, and (3) audit trail data.

Data Elements to be Reported

Objective analysis data are:

1. Task or objective number generated during analysis (also mission and phase numbers).
2. Task or objective statement (also mission and phase titles).
3. Conditions of performance.
4. Standards of performance.
5. Common phase and task or objective numbers.
6. Crew positions involved in the performance of the task.

ET development data are:

1. Objectives classification (and certainty codes, if assigned).
2. Task or objective perishability rating.
3. Task or objective criticality rating (and certainty codes, if assigned).
4. ET nomination.
5. Implementation approach for objective within ET.

Audit trail data are:

1. Source of task or objective description information.
2. Page reference within the information source.

Content of Data Elements

The above data elements are explained here. Justification of the content and examples of the data elements are included as appropriate.

Task or Objective Number. This is assigned to the task or objective by the analysis team. The numbering system is hierarchical; longer numbers represent lower-order tasks or objectives that enable the performance of higher-order task or objectives. A convenient approach is to use two digit numbers to represent mission phases (or other functional break-outs) (e.g., 02, Mission Preparation phase), two additional digits separated from the phase digits by periods to represent tasks (e.g., 02.06, Load Ammunition), two more digits to represent subtasks, and so forth for finer subdivisions, with each two digits separated from the previous pair by a period. Each lower-order subtask is required for the proper performance of the higher-order element.

Task Statement. This is a title or description of the task or objective. The wording of the task or objective descriptions should be chosen carefully. Each description of a task, subtask, etc. should be able to stand alone. That is, if the description were to be written outside the context of the task or objective elements above and below it, the reader should understand it. For example.

Incorrect

02.06.01	Perform a receipt inspection on the projectile.
02.06.01.01	Unpackage.
02.06.01.02	Inspect.

Correct

02.06.01	Perform a receipt inspection on the projectile.
02.06.01.01	Unpackage the projectile.
02.06.01.02	Inspect the projectile.

Conditions of Performance. These are the circumstances under which the task is performed as identified in Phases One and Two.

Standards of Performance. This is how well an action must be performed. For the ETR, this statement only specifies the measure or dimension of performance measurement (e.g., speed of trigger pull, distance from target), and not the actual values.

Common Task or Objective Numbers. Some activities are called for more than once in an objectives hierarchy. For instance, "Prepare for firing" might appear under both manual and automatic firing objectives. All the numbers that refer to the same activity are common task/objective numbers.

Crew Position. These are the crew positions that are involved in the performance of the particular task, and are the targets of training. A task or objective that has lower-level subtasks includes the crew positions that are involved in the subtasks. Note that entry of multiple crew positions indicates that there may be a need to provide team training or coordinated training for the crew positions involved.

Objectives Classification. This is the classification of the objective into one of seven types, performed during Phase Three. This information is used in the rating of perishability, and is described in Section 4. If certainty codes were assigned, they also appear here.

Perishability Rating. Perishability is defined as the likelihood that task performance will suffer if the task is not practiced. This rating can take values of low, medium, or high. Task perishability is inferred from the objective classification, which is performed in Phase Three. A procedure to generate task perishability ratings is found in Section 4. Certainty codes, if assigned, also appear in this field of data.

Criticality Rating. Criticality is defined as the likelihood that a given task may result in mission failure, personal injury, or damage to equipment. This rating can take values of low, medium, or high. Criticality ratings are performed in Phase Three, and the classification scheme is presented in Section 4.

ET Nomination. This nomination is a product of the ET decision model that is applied in Phase Three. There will be a nomination of the suitability for ET for each objective.

Implementation Feasibility Code. This is the code assigned during assessment of the implementation potential of each ET-nominated objective, in Phase Three. Codes which will appear in this data field are described in Section 4.

Source of Information. This is a statement of where the information for the task or objective description or other data were obtained. As the task or objective analysis is developed to the appropriate level of detail it sometimes becomes unclear where the information about a task or objective or subtask came from. Sources of data include original task listings, Plans of Instruction (POIs), training manuals, engineering data, system development briefings, SME inputs, and so forth. A training feature may be developed to serve a particular training need, and questions may arise about the substance of this task. The source of information pinpoints the exact wording of

original task or objective information and also helps in evaluating the currency of the information source. Document numbers should be included. This field should be initially used when source information is first identified and used in task identification. The field should be expanded or updated if new information is gathered or discovered.

Page or Reference Number. Information about where in the source the information was found speeds checking of the original source documentation.

Military Service Task or Objective Number. If the original source or information for this task or objective was a military task or objective listing, then there is a task or objective number already assigned to the task. This number should be included in the audit trail data, even if subsequent editing results in minor word changes. Note that this is only the administratively-accepted task number which corresponds to an identified task. The "working" task number (see Phase Two and Appendix C) is used for analysis. The number in this field is included to provide a cross-reference to official documentation which may have been used as source material.

Products

Reports are relatively easy to generate if the data collection has made use of a computer-based DBMS, because these systems usually have built-in report generators that can structure the data output to fit the formats described.

The above data elements could be reported in one large printout, but this would require that they be listed sequentially for each objective. This approach is not amenable to rapid overview and quick consultation for analytic and decision making purposes.

An approach that is better suited to further analysis is to present the data in matrix form, with each objective occupying a row in the matrix, and with the proper data elements in columns. Using this approach, there is too much information for either dimension, rows or columns, to fit on a page. The solution is to generate separate reports that include the data required for the purposes of each report. This approach is taken for all but the first report, which is an objective analysis reference document. An example of such a report format is shown in Figure 7.

There are two data elements that are common to all reports: task or objective number and task or objective statement. It is difficult to make sense out of a report without the description, and the number provides a unique reference. Reports are designed so that they can

Task Number	Task Description	Crew	PR	CR	ET	Train Level
03	MOVEMENT	CS,D	M	H		A,S,F
03.01	Move to the Initialization Survey Point (ISP)	CS,D	L	M	Y	A
03.01.01	Drive the SPH	D	L	M	N	A
03.01.01.02	Press and hold the brake pedal	D	L	M	N	A
03.01.01.03	Release the handbrake	D	L	M	N	A
03.01.01.04	Shift into 1st gear	D	L	M	N	A
03.01.01.05	Release the brake pedal	D	L	M	N	A
03.01.01.06	Press the accelerator pedal	D	L	M	N	A
03.01.01.07	Shift the transmission gears as required	D	L	M	N	A
03.01.01.08	Steer the vehicle as required	D	L	M	N	A
03.01.01.09	Respond to the orders from the chief of section	D	L	M	N	A
03.01.01.10	Perform the During (D) Preventive Maintenance Checks and Services (PMCS)	D	L	M	N	A
03.01.01.11	Maneuver the SPH so the left sprocket is next to the survey point	CS,D	L	M	N	A
03.01.01.12	Use visual signals to control movement (mounted)	CS	L	M	N	A

Figure 7. Example report form.

easily be printed and published. All but the first report are of a size that can be printed across wide paper (130 columns), which can be bound sideways in a report; the first is standard width (75 columns).

Report 1--Task or Objective Analysis Overview

This report contains the basic task or objective analysis information. Its data elements are: task or objective number, task or objective statement, crew positions, conditions of performance, standards of performance, and common task or objective numbers. Each data element is listed sequentially as a separate row, unlike the other reports. This report is sorted or indexed by task or objective number. This information is useful during efforts aimed at producing courseware or generating a final task analysis.

Report 2--ET Nominations

This report is printed in 130 columns and contains: task or objective number, task or objective statement, crew positions, objectives classification, perishability rating, criticality rating, ET nomination, and implementation approach. The purpose of this report is to be able to look at all tasks and see which ones are nominees for ET along with the data supporting this nomination. This report is sorted or indexed by task or objective number.

Report 3--ET Nominations and Implementation Judgments

This report is printed in 130 columns and contains: task or objective number, task or objective statement, ET nomination, and implementation approach. It is useful to present this report indexed by task or objective number.

Report 3A--Crew Position Breakdown

This is a series of ET nomination and implementation judgment reports, one for each crew position. Only the data pertaining to the individual crew position should be included in each report. This report is of use when revising prior training and training guidance material already organized by crew position. These reports also provide a clear picture of how many ET-nominated objectives and tasks pertain to each crew position.

Report 3B--ET Task or Objective Listing

This is an optional report that presents the data of Report 3, but only for those tasks for which ET is nominated. The ET nomination

column is deleted. If the full task listing is quite large, then this listing is useful in reviewing ET and determining requirements for implementation.

Report 4--Audit Trail

This report is printed in 130 columns and contains: task or objective number, task or objective statement, source of information for the task or objective statement, page reference within the information source, and military service task or objective number (if applicable).

Report 5--Common Task or Objective Numbers

This report is printed in 130 columns and contains: task or objective number, task or objective statement, and common task or objective numbers. The common task or objective numbers are often quite long, and this mode of presentation simplifies looking them up when creating courseware.

APPENDIX A

WEAPON SYSTEM OPERATIONAL MISSION MODEL

This Appendix presents a generic mission model that can be applied to some types of weapon systems during the task analysis. The model aids analysts in structuring the tasks into a hierarchical form. This model is suitable only for ground-based weapon systems and their operational missions. The model uses the following phases to describe the operational mission:

1. Planning
2. Preparation
3. Movement
4. Deployment
5. Operation
6. Replenishment/Resupply
7. Post-Mission

The first two phases normally occur once during a mission. Phases three, four, five, and six can occur numerous times and in different order during a mission. The final phase normally occurs once, at the end of the mission. Figure A-1 presents these phases in hierarchical form.

Planning Phase. Crews perform some planning tasks which are normally covered by doctrine in the form of Standard Operating Procedures (SOP). These tasks are often performed at a briefing site and result in a briefing to disseminate mission information.

Preparation Phase. Tasks associated with weapon system initialization, Preventive Maintenance Checks and Services (PMCS), communications checks, and operator maintenance.

Movement Phase. Transporting and navigating the weapon system. It includes movement to, within, and from the deployment site. Contingencies such as navigational system failure are important during this phase.

Deployment Phase. Emplacement, camouflage, and defense posture of the weapon system. It may include initialization procedures for weapon subsystems secured during movement.

Operation Phase. Operating the weapon system and engaging the enemy. In sensor driven weapon systems, this phase is divided into search, detect, track, acquire, identify and classify, engage, and assess engagement. Other aspects of this phase may include: operating communications equipment; performing unusual operations, such as fire-fighting or NBC warfare; and contingencies, such as response to weapon system equipment failures and response to tactical changes.

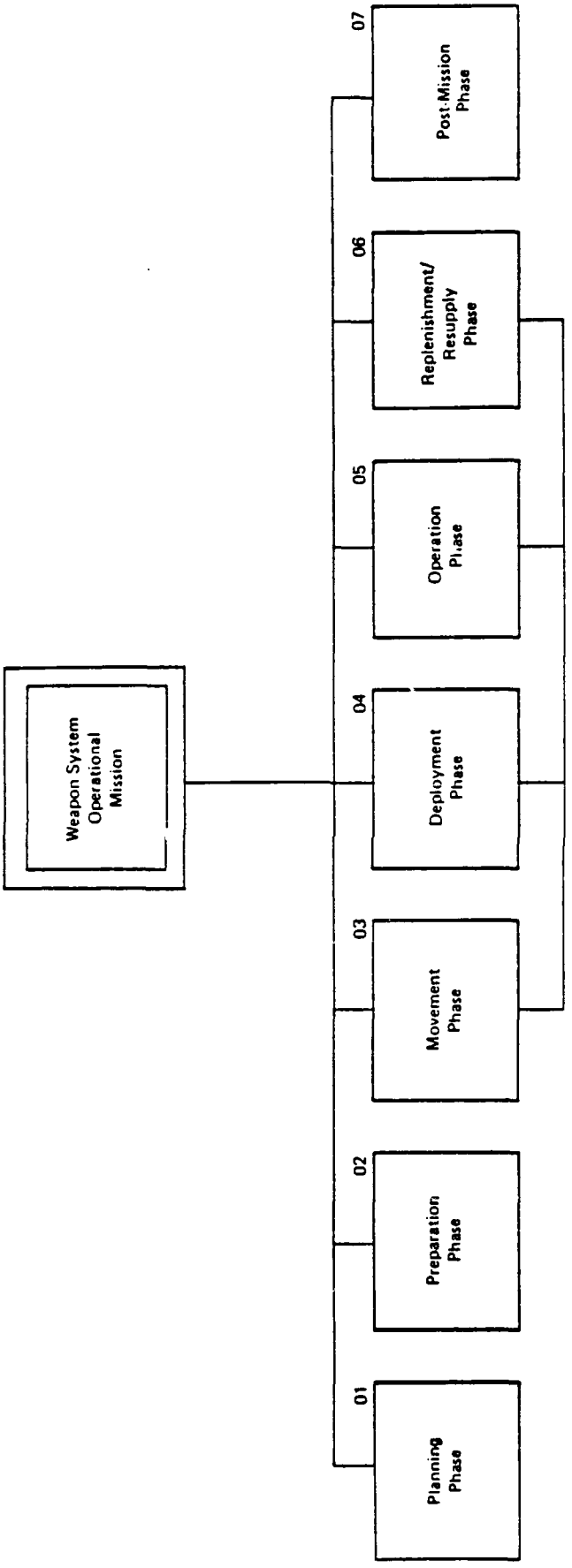

Figure A-1. Weapon system operational mission model.

Replenishment or Resupply Phase. Resupplying ammunition, fuel, and other commodities needed by the weapon system. This phase may include requesting a resupply mission and coordinating a rendezvous with a resupply vehicle.

Post-Mission Phase. Weapon system shutdown, clean-up, and post-mission preventive maintenance checks and services, and mission debrief. Most of the tasks in this phase are procedures.

APPENDIX B

TASK OR OBJECTIVE ACTION VERBS AND THEIR DEFINITIONS

INTRODUCTION

This Appendix lists action verbs that may be used in a task or objective title and its definition. Some specialized verbs, not listed here, may be needed for particular weapon systems. For example, "lay" is commonly used in task or objective titles for cannon-type weapon systems, but is not applicable to all weapon systems. Verbs for operator maintenance tasks or objectives are included in this listing. Many of the verbs presented here are synonymous. The analysts should select the one verb which appears to be best and use it consistently throughout the analysis.

This verb list is an expanded version of the action verb list contained in Air Force Pamphlet 50-58, Instructional Systems Development. Expansions were derived because of a need to include verbs associated with primarily cognitive-type tasks, that did not appear in the original listing.

Access	1. To gain visibility of or the ability to manipulate. 2. To cause to be displayed, as with a computer menu.
Accomplish	To do, carry out, or bring about; to reach an objective.
Achieve	To carry out successfully.
Acknowledge	To make known the receipt or existence of.
Actuate	To put into mechanical motion or action; to move to action.
Adjust	1. To bring to a specified position or state. 2. To bring to a more satisfactory state; to manipulate controls, levers, linkages, etc.; to return equipment from an out-of-tolerance condition to an in-tolerance condition.
Administer	To manage or supervise the execution, use, or conduct of.
Advance	To move forward; to move ahead.
Advise	To give information or notice to.
Alert	To warn; to call to a state of readiness or watchfulness; to notify (a Person) of an impending action.
Align	To bring into line; to line up; to bring into precise adjustment, correct relative position; or coincidence.
Allocate	To apportion for a specific purpose or to particular persons or things.
Allow	1. To permit; to give opportunity to. 2. To allot or provide for. 3. To carry out a procedure.
Analyze	To examine and interpret information.
Annotate	To append explanatory information to a text or graphic summary of information.
Announce	To make known.
Apply	1. To lay or spread on. 2. To energize.

Archive	To make an archival copy of.
Arrange	To group according to quality, value, or other characteristics; to put in proper order.
Assemble	To fit and secure together the several parts of; to make or form by combining parts.
Assess	To determine the importance, size, or value of; to evaluate.
Assign	To apportion to for a specific purpose or to particular persons or things; to appoint to a duty.
Assist	To give support or help; to aid.
Attach	To join or fasten to.
Authenticate	To prove or serve to prove the authenticity of.
Balance	To equalize in weight, height, number, or proportion.
Brief	To give final precise instructions; to coach thoroughly in advance; to give essential information to.
Calculate	To determine by arithmetic processes.
Calibrate	To determine accuracy, deviation, or variation by special measurement or by comparison with a standard.
Camouflage	To conceal or disguise by camouflage.
Cancel	To cause not to occur, as in cancelling a command.
Categorize	To put into categories or general classes.
Center	1. To adjust so that axes coincide. 2. To place in the middle of.
Change	1. To replace with another comparable item or information entity. 2. To adjust.
Check	1. To confirm or establish that a proper condition exists; to ascertain that a given operation produces a specified result; to examine for satisfactory accuracy, safety, or performance; to confirm or

	determine measurements by use of visual or mechanical means.
	2. To perform a critical visual observation or check for specific conditions; to test the condition of.
Chock	To place a blocking device adjacent to, in front of, and behind a wheel to keep from moving.
Choke	To enrich the fuel mixture of a motor by partially shutting off the air intake of the carburetor.
Choose	To select after consideration.
Chunk	To cause the association of several entities.
Classify	To put into categories or general classes.
Clean	To wash, scrub, or apply solvents to; remove dirt, corrosion, or grease.
Clear	1. To move people and/or objects away from.
	2. To open the throttle of an idling engine to free it from carbon.
Close	1. To block against entry or passage; to turn, push, or pull in the direction in which flow is impeded.
	2. To set a circuit breaker into the position allowing current to flow through.
Collect	To bring together into one body or place; to accumulate.
Command	To direct authoritatively.
Communicate	1. To exchange information.
	2. To make known.
Compare	To examine the character or qualities of two or more items; to discover resemblances or differences.
Complete	1. To bring to an end.
	2. To supply missing or needed information, normally in a prescribed format.
Comply	To conform with directions or rules; to accept as authority; to obey.

Compute	To determine by arithmetic processes.
Condense	To make denser, more brief, or more compact.
Connect	1. To bring or fit together so as to form a unit, to couple keyed or matched equipment items. 2. To attach or mate (an electrical device) to a service outlet.
Construct	1. To make or form by combining parts; to fit and secure together the several parts of. 2. To assemble information elements or entities in a specified fashion.
Control	To exercise restraining or directing influence over; to fix or adjust the time, amount, or rate of.
Coordinate	To bring into a common action, movement, or condition.
Correct	To make or set right, to alter or adjust so as to bring to some standard or required condition.
Correlate	To establish a mutual or reciprocal relation between.
Cover	To protect or shelter by placing something over or around.
Create	To cause to come into being, normally based on some established criterion.
Decide	To arrive at a solution.
Deenergize	To take energy from.
Define	1. To determine or identify the essential qualities or meaning. 2. To fix or mark the limits of.
Deflate	To release air or gas from.
Delete	To remove from association with or cause to no longer exist.
Deliver	1. To hand over. 2. To send to an intended target or destination.
Demonstrate	To show clearly.
Depart	To go away; to leave.

Depressurize	To release gas or fluid pressure from.
Derive	To infer or deduce.
Describe	To represent or give an account of in words.
Destroy	To ruin, demolish, or put out of existence; to make unfit for further use.
Detect	To discover or determine the existence, presence, or fact of.
Determine	1. To obtain definite and first-hand knowledge of, to confirm, or establish that a proper condition exists. 2. To investigate and decide to discover by study or experiment.
Develop	To set forth or make clear by degrees or in detail.
Diagnose	To recognize and identify the cause or nature of a condition, situation, or problem by examination or analysis.
Disassemble	To take to pieces; to take apart to the level of the next smaller unit or down to all removable parts.
Disconnect	1. To sever the connection between; to separate keyed or matched equipment parts. 2. To detach or separate (an electrical device) from a service outlet.
Discriminate	To distinguish or differentiate by discerning or exposing differences.
Disengage	To release or detach interlocking parts; to unfasten; to set free from an inactive or fixed position.
Display	To cause a visual image to be presented on some medium.
Dispose of	To get rid of.
Distinguish	To perceive a difference in.
Distribute	1. To apportion for a specific purpose or to particular persons or things. 2. To divide among several or many; to divide or separate, especially into kinds.

Drain	To draw off (liquid) gradually or completely.
Draw	To produce a likeness or representation of.
Drive	To direct the course and motions of a vehicle.
Edit	To correct errors of grammar, syntax, and content in text material.
Egress	To go out.
Elaborate	To provide more detail regarding.
Elevate	To lift up; to raise.
Eliminate	To expel; to ignore or set aside as unimportant.
Emplace	To put into position.
Employ	To put into action or service; to carry out a purpose or action by means of; to avail oneself of.
Energize	To impart energy to.
Enforce	To compel or constrain.
Engage	1. To cause to interlock or mesh. 2. To enter into conflict.
Enter	1. To go or come in. 2. To put on record. 3. To put in information or data.
Erect	To put up by the fitting together.
Establish	To set on a firm basis.
Estimate	To judge or determine roughly the size, extent, or nature of.
Evaluate	To determine the importance, size, or nature of; to appraise; to give a value or appraisal to on the basis of collected data.
Exchange	To part with or substitute.
Execute	To carry out fully.
Explain	To make something plain and understandable.

Express	To represent in words; to state.
Extract	To draw forth; to pull out forcibly.
Fill out	To enter information on a form.
Find	1. To discover or determine by search; to indicate the place, site, or limits of. 2. To discover by study or experiment; to investigate and decide.
Fire	To launch a missile or shoot a gun.
Hold	To have or keep in the grasp.
Hypothesize	To develop a prediction or speculation, of some degree of uncertainty, based on incomplete factual information or theory.
Identify	1. To establish the identity of. 2. To determine the classification of.
Illustrate	To make clear or clarify.
Indicate	To point out.
Inform	To make known to; to give notice or report the occurrence of.
Initialize	To place in an initial or beginning condition.
Input	To enter information into a computer or data system.
Insert	To put or thrust in, into, or through.
Inspect	To perform a critical visual observation or check for specific conditions; to test the condition of.
Install	1. To perform operations necessary to properly fit an equipment unit into the next larger assembly or system. 2. To place and attach.
Instruct	To provide with authoritative information or advice.
Integrate	To bring together information from two or more different sources for the purpose of combined analysis or presentation.

Intercept	To stop or interrupt the progress or course of.
Interpret	1. To conceive in the light of individual belief, judgment, or circumstance. 2. To explain the meaning of.
Investigate	To observe or study by close examination and systematic inquiry.
Isolate	To use test equipment to identify or select a source of trouble.
Issue	To put forth or distribute.
Lift	To move or cause to be moved from a lower to a higher position; to elevate.
List	To enumerate; to place a group of items together.
Listen	To hear something with thoughtful attention.
Load	To place in or on; to place cargo or aircraft components on an airplane or other vehicle.
Locate	1. To find, determine, or indicate the place, site, or limits of. 2. To set or establish in a particular spot; to station.
Log	1. To record for purposes of keeping records. 2. To gain access to a computer system or terminate interaction with a computer system.
Lubricate	To put lubricant on specified locations.
Maintain	1. To hold or keep in any particular state or condition, especially in a state of efficiency or validity. 2. To sustain or keep up.
Manage	To handle or direct with a degree of skill.
Maneuver	To make a series of changes in direction and position for a specified purpose.
Manipulate	To operate with the hands.
Measure	To determine the dimensions, capacity, or amount by use of standard instruments or utensils.

Modify	To alter or change somewhat the form or qualities of.
Monitor	1. To visually take note of or to pay attention to in order to check on action or change. 2. To continually or periodically attend to displays to determine equipment condition or operating status.
Mount	To attach to a support.
Move	To change the location or position of.
Name	To identify by name.
Navigate	To operate and control course of.
Neutralize	To destroy the effectiveness of; to nullify.
Notify	To make known to; to give notice or report the occurrence of.
Observe	1. To conform one's actions or practice to. 2. To visually take note of; to pay attention to.
Obtain	1. To get or find out by observation or special procedures. 2. To gain or attain.
Open	1. To move from closed position; to make available for passage by turning in an appropriate direction. 2. To make available for entry or passage by turning back, removing, or clearing away. 3. To disengage or pull out a circuit breaker.
Operate	To control equipment in order to accomplish a specific purpose.
Organize	To arrange elements into a whole of interdependent parts; to form into a coherent unity; to integrate.
Orient	1. To acquaint with the existing situation or environment. 2. To set or arrange in any determinate position.
Originate	To give rise to, to set going, to begin.

Park	To bring a vehicle to a stop and leave it standing for a time in a specified area.
Perform	To do, carry out, or bring about; to reach an objective.
Place	To put or set in a desired location or position.
Plan	To devise or project the achievement of.
Plot	To mark or note on or as if on a map or chart; to locate by means of coordinates.
Position	To put or set in a given place.
Post	To station at a given place.
Prepare	To make ready; to arrange things in readiness.
Prescribe	To lay down as a guide, direction, or rule of action; to specify with authority.
Press	To act upon through thrusting force exerted in contact.
Pressurize	To apply pressure within by filling with gas or liquid.
Prevent	To keep from happening or existing.
Prioritize	To arrange or list in order of priority or importance.
Process	To submit to a series of actions or operations leading to a particular end.
Produce	To cause to come into being or visibility.
Program	To work out a plan or procedure or a sequence of operations to be performed.
Provide	To supply what is needed, to equip.
Pull	To exert force upon an object so as to cause motion toward the force.
Pump	1. Raise or lower by operating a device which raises, transfers, or compresses fluids by suction, pressure or both. 2. To move up and down or in and out as if with a pump handle.
Purge	1. To expel unwanted fluids from. 2. To cause to be eliminated or dissociated from.

Push	1. To press against with force so as to cause motion away from the force. 2. To move away or ahead by steady pressure.
Qualify	To declare competent or adequate.
Queue	To cause to be placed in a queue or ordered sequence of similar processes.
Raise	To move or cause to be moved from a lower to a higher position; to elevate.
Read	To derive information from written material.
Recall	To bring forth information from memory.
Receive	To come into possession of; to get.
Recognize	To perceive to be something previously known or designated.
Record	To set down in writing.
Recover	To get back; to regain.
Refuel	To put fuel into the tanks of a vehicle again.
Release	1. To set free from an inactive or fixed position; to unfasten or detach interlocking parts. 2. To let go of. 3. To set free from restraint or confinement.
Remove	1. To perform operations necessary to take an equipment unit out of the next larger assembly or system. 2. To take off or eliminate. 3. To take or move away. 4. To take off devices for closing off the end of a tube.
Repair	To restore damaged, wornout, or malfunctioning equipment to a serviceable, usable, or operable condition.
Repeat	To make, do, or perform again.

Replace	1. To restore to a former place of position. 2. To substitute serviceable equipment for malfunctioning, wornout, or damaged equipment.
Report	1. To describe as being in a specified state. 2. To make known to; to give notice or report the occurrence of.
Represent	To cause information to be conveyed in a fashion different from the original.
Request	To ask for.
Reset	To put back into a desired position, adjustment, or condition.
Resolve	To eliminate discrepancies from two or more sources of information.
Respond	To react.
Retrieve	To cause to be removed from storage or other unavailable state and made accessible.
Review	To examine again; to go over or examine critically or deliberately.
Rotate	To cause to revolve about an axis or center.
Route	To send by a selected course of travel; to divert in a specified direction.
Run	To cause a computer program to be executed by a computer.
Save	To cause to be stored or placed in an accessible location.
Scan	To make a wide, sweeping search of; to look through or over hastily.
Schedule	To appoint, assign, or designate for a fixed future time; to make a timetable of.
Search	To examine a context to determine the presence of a particular entity or type of entity.
Secure	To make fast or safe.
Select	To take by preference or fitness from a number or group; to pick out; to choose.

Send	To dispatch by means of communication.
Service	To perform such operations as cleanup, lubrication, and replenishment to prepare for use.
Set	1. To put a switch, pointer, or knob into a given position; to put equipment into a given adjustment, condition a mode. 2. To put or place in a desired orientation, condition, or location.
Set up	To prepare or make ready for use.
Show	To point out or explain.
Shut down	To perform operations necessary to cause equipment to cease or suspend operation.
Sight	1. To look at through or as if through a sight. 2. To aim by means of sights.
Signal	To notify or communicate by signals (i.e., a prearranged sign, notice or symbol conveying a command, warning, direction or other message).
Solve	To find a solution for.
Specify	To name or state explicitly or in detail.
Squeeze	To force or thrust together by compression.
Start	To perform actions necessary to set into operation; to set going; to begin.
State	To express the particulars of in words.
Stay	To remain; to continue in a place.
Steer	To direct the course of.
Stop	To perform actions necessary to cause equipment to cease or suspend operation.
Store	To cause to be placed in an accessible location.
Stow	To deposit or leave in a specified place for future use.
Strike	To deliver or aim a blow or thrust; to hit.

Submit	To make available; to offer.
Summarize	To tell in or reduce to a summary.
Supervise	To oversee; to have or exercise the charge of.
Synthesize	To combine or produce by synthesis.
Take	1. To get into or carry in one's hands or one's possession. 2. To get or find out by observation or special procedures.
Tap	To strike lightly.
Tell	To express in words.
Test	To perform specified operations to verify operational readiness of a component, subcomponent, system, or subsystem.
Tighten	1. To perform necessary operations to fix more firmly in place. 2. To apply a specified amount of force to produce a rotation or twisting motion to fix more firmly in place.
Trace	To follow or study out in detail or step by step.
Transfer	To cause an entity to change location or association with other entities.
Transmit	1. To convey or cause to pass from one place to another. 2. To send out a signal by radio waves or wire.
Transport	1. To convey or cause to pass from one place to another. 2. To carry by hand or in a vehicle or hoist, or in a container, etc.
Traverse	To move from side to side.
Troubleshoot	To localize and isolate the source of a malfunction or break down.
Turn	To cause to revolve about an axis or center.

Type	To enter information into a device by means of a keyboard.
Unload	To take off.
Update	To replace older, possibly invalid, information with more current information.
Use	To put into action or service; to avail oneself of; to carry out a purpose or action by means of.
Utilize	To put into action or service; to avail oneself of; to carry out a purpose or action by means of.
Validate	To ascertain the correctness of, using an independent source of information.
Verify	1. To confirm or establish that a proper condition exists. 2. To establish the truth or accuracy of.
Visualize	To create a mental picture or concept of.
Wait	To suspend activity in a sequence of activities until a given condition occurs or a given time has elapsed.
Write	To inscribe words on a surface.
Zero	To bring to a desired level or null position.

APPENDIX C

DATABASE MANAGEMENT SYSTEM (DBMS) USE AND SUGGESTED TECHNIQUES FOR ET REQUIREMENTS ANALYSIS

Introduction

This Appendix discusses how to use a Database Management System (DBMS) for ET requirements analysis. Techniques presented are suggestions, not rules. Use of these guidelines depends on the DBMS and the purpose of the analysis. The information is presented in three parts. First is the suggested structure of the database for an ET requirements analysis, and second are techniques and commands which can aid the analyst using a DBMS. Following the discussion on database structure and DBMS use, a set of forms for use in interim recording of analysis products (before they reach the database) is described, and their use in the steps of the analysis process is discussed. It is necessary to have a basic knowledge of computer operation to use the information in this Appendix.

Database Structure

The database structure is presented in four categories: task/objective characteristics, audit trail information, analysis information, and additional data elements for future analyses. Each category contains a list of suggested data elements to include in the database, type of data element or field it represents, and, when applicable, the size of the element.

Task/Objective Characteristics

Title/Description. This is a short but accurate description, beginning with an action verb, followed by a proper noun and modifiers. There is a title/description for each task or objective. In the DBMS, this is a character/text type data element of at least 120 character length.

Number. This is the task or objective number which is unique for each task or objective. The numbering system can be a sequential numbering system for listings or, in the case of a hierarchy, a numbering system indicating the level of the task/objective. The numbering system suggested is double digits separated by periods. For example, "01.02.03" indicates the task/objective is the third subtask, in the second task, of the first phase. The example below shows how the numbering system indicates the task/objective relationship with other tasks/objectives in the hierarchy.

01	Planning Phase.
01.01	Collect weather information.

01.01.01	Communicate with weather center.
01.01.02	Record relevant weather information.
01.02	Determine route to combat area.
01.02.01	Examine maps of ops area.

There is a unique number for each task/objective. If the numbering system is sequential, the data element is a character/text type of at least five characters. For task/objective hierarchies, the data element is character/text of at least 23 characters. This is equal to eight hierarchical levels (i.e., 01.02.03.04.05.06.07.08).

Conditions of Performance. There can be numerous conditions for each task/objective. Conditions are enumerated in a prioritized order within this data element. In the DBMS, the data element is a character/text type large enough to accommodate text descriptions of conditions.

Standards of Performance. There can be numerous standards for each objective. Standards are enumerated in a prioritized order within this data element. In the DBMS, the data element is a character/text type large enough to accommodate text descriptions of standards.

Crew Positions. With multi-crew member weapon systems it is important to keep track of which crew members perform the task/objective. The analyst should include one logical (boolean) data element for each crew position to indicate whether the task/objective is performed by that crew member. A logical type data element is simply a Yes/No or True/False indicator. It may be desirable to include a character/text data element for recording the actual crew position name. The character/text type data element is better for printouts than the logical type, while the logical type is better for database manipulations such as counts and restricted printouts.

Common Numbers. This is a list of the other task/objective numbers in the hierarchy which are equivalent to the current task/objective description. A particular task or objective may occur numerous times in the hierarchy. To keep track of this, a character/text type data element of a large size contains the list of numbers in order of appearance in the hierarchy. This data element is only used for hierarchies and not for sequential listings.

First Appearance Indicator. This is a logical type data element which indicates whether this is the first occurrence of the task/objective in the hierarchy. This is only used for hierarchies and not sequential listings.

Audit Trail Information

Source of Information. This data element is a record of the document or other source from which the task/objective was derived. It

may be useful to note the agency responsible for developing the task/objective. The data element of the DBMS is a character/text type of at least 60 characters.

Page/Reference Number. When the task/objective is derived from a specific document, the page number or other relevant reference number is recorded in this data element. The data element in the DBMS is a character/text type of at least 15 characters.

Task/Objective Developer. This data element denotes the analyst or Subject Matter Expert (SME) who developed a new task/objective. This data element is a character/text type of at least 10 characters. Separate initials can be separated by commas or slashes.

Military Service Task/Objective Number. This data element is used when a task/objective in the developing hierarchy is equivalent to a task/objective currently in the military service. The military task number is often found in a POI, training guide, or soldier's manual. The data element is a character/text type of at least 25 character length.

Analysis Information

Criticality Rating. This is a character/text type data element of one character. The codes are H(igh), M(edium), and L(ow). There is a criticality rating for each task/objective. If certainty codes are to be assigned to criticality ratings, they also appear in this field.

Perishability Rating. This is a character/text type data element of one character. The codes are H(igh), M(edium), and L(ow). There is a perishability rating for each task/objective.

ET Nomination. This is a logical type data element which indicates whether ET is suitable to train the task/objective. There is one data element for each crew position in the weapon system for each task/objective.

Objectives Classification. This data element is used when the analysis is performed on an objectives hierarchy. Each objective can be classified as one of seven types of objectives: integrated multiple skills, rule/concept utilization, variable/contingency procedures, knowledges, invariant procedures, basic manipulative skills, and basic level behaviors. This classification is described in Section 4. If certainty codes for objectives classification are used, they also appear in this field.

ET Implementation. This data element is the ET implementation and feasibility judgment code assigned in Step 3.5 of the analysis. This is a character/text data element one character long.

Additional Data Element for Future Analyses

Training Media. This data element contains the media appropriate for training the task/objective. The media can be selected using a media selection model. The data element in the DBMS is a character/text type large enough to accommodate the media names.

ET Comments. This data element describes the method of training the task/objective by ET envisioned by the analyst who nominates this task for ET. For instance, if "Operate the radar" is the task, "Simulated radar targets and use of actual radar controls" would be the ET comment. This data element is a character/text type of at least 120 characters.

DBMS Analysis Techniques, and Commands

Indexing and Sorting the Database

A database can be indexed or sorted on any data element. The difference between index and sort is that the index is a logical arrangement of the database, whereas the sort is a physical reordering of the database records. Indexing is faster and does not require additional storage space. A sort normally requires three times the space of the database and if there is not enough room on the storage device for a sort, loss of data can occur.

Another application of an index is to organize the database by title/description. This is useful when identifying and standardizing common tasks/objectives and finding the initial occurrence of the task/objective. This is used during the commonality analyses (Steps 1.6 and 1.8).

Character/Text Types and Logical Types

The advantage to using a character/text type data element in a database is that it is descriptive and useful for printouts. The logical type data elements are, however, better for DBMS features. For example, it is easier to print out tasks/objectives for a particular weapon system operator, by searching for a yes/no indicator for that operator. On the other hand, for the printout, operator names may be clearer than a Y or N in a column for that operator.

Find/Locate Commands

Most DBMSs have a find or locate feature. This allows the person entering information or changing data to access a specific record. For instance, if the DBMS contains descriptions and numbers the next action may be to enter other information for certain tasks/objectives. It is quicker to call the task/objective of interest than it is to scroll through the database manually.

Count Commands

Some DBMSs have built-in counting features. This is useful during analysis to assess the number of times something occurs. For example, if the analyst wants to know how many ET nominated tasks/objectives there are, the DBMS can count faster than a person with a printout. Logical type data elements are useful for counting.

Replace Commands

Some DBMSs have a replace feature. This allows the user to enter information automatically in a data element for a specified condition. For instance, if all of the newest entries are from the same document, the data entry person can enter one letter, (e.g., "X"). After entering all the data, the user can replace all occurrences of "X" with the actual source document name.

Structure to Facilitate Data Entry

Generally, a task/objectives hierarchy is developed in stages. First, the title/description is entered and then numbers are assigned. The remainder of the information is added after these steps. To facilitate data entry, the data elements should be ordered as they will appear on the data entry forms or in the order they will be entered. Some DBMSs allow the user to modify the format of the data entry presentation, which simplifies data entry. This allows the user to present a screen for data entry which looks like the data entry form.

Deleting Records

A task/objective should not be permanently deleted from the database until it is certain that the task/objective is not needed. Some DBMSs can designate records as logically deleted rather than physically erasing them from the database. By using this capability, tasks/objectives can be screened out, without losing the data. Even when it is determined that a task/objective is not needed, the

task/objective should be placed in a separate file of deleted tasks/objectives as a safety measure.

Report Generation

Most DBMSs have an automatic report generator. Experience has shown that it is usually faster to use the automatic feature rather than program a customized report generating program. In the case when an customized report is desired, it is sometimes possible to use the automatic report generator to create a text file and then use a word processor to customize it.

Programming with the DBMS

Most DBMSs have all of the needed functions and capabilities built into the command language. It is suggested that the casual DBMS user not spend time writing programs using the DBMS programming capabilities. Most DBMSs do not have a full programming capability. Even though it may appear to be similar to a known programming language, it may have its own stumbling blocks.

Database Entry, Interim Recording Forms, and Data Printouts for ETR Analysis

ETR analysis data are entered in various stages during analysis. A data entry form and five printout formats, used during specific steps of the ETR analysis, are presented to assist the DBMS user. Table C-1 shows the data elements generated in the analyses and discussed in this Appendix and the form each is associated with.

The forms are discussed in detailed below. The printout formats follow the assumption that the printer used by the DBMS is capable of printing on wide paper, either 11 inches for 8.5 x 11 inch paper or, preferably, 11 X 14 inch paper. The paper can be sheet fed or tractor fed (preferable). It is important to note that all data elements are under continuous refinement, even though they may not appear on a form. The printouts can be used while the DBMS is on line with the analyst entering new data elements directly into the database, or the analyst can make entries on the printout and have clerical personnel enter the information into the database later.

Form 1 is used for Steps 1.3, 1.4, 1.5, 1.7, and 2.1 of the ETR analysis. This is a data entry form which has places to record the task/objective number, title/description, conditions of performance, crew positions performing each task/objective, and audit trail information. This form is used for mission, mission phase, task/objective, and subtask/subobjective identification. Once the data

Table C-1

Data Element vs. Data-entry/printout Form

Input/output Forms for ETR Analysis

Data Element	Entry Form 1	Printout Form 2	Printout Form 3	Printout Form 4	Printout Form 5	Printout Form 6
Number	I	O	O	O	O	O
Title/Description	I	O	O	O	O	O
Conditions	I			O	O	
Standards				I	O	
Crew Positions	I		O	O	O	O
Common Numbers		I				
First Appearance		I				
Source	I					
Page No.	I					
Developer	I		O/I			
Mil. Task No.	I					
Criticality			I		O	O
Objective Class.			I		O	O
Perishability			A		O	O
ET Nomination			A		O	O
Implementing ET					I	O

I - Initial entry of this data element.
O - Output data element to assist entry of other data element.
A - Automatically computed and entered by the DBMS program.

is entered on the form, clerical personnel (or the unlucky analyst) can enter the data into the DBMS.

Form 2 is used for Steps 1.6 and 1.8 of the ETR analysis. This is a printout of information contained in the DBMS database with blank columns for data elements generated in these steps, which are to be entered into the database. The printout is indexed on the mission phase or task title/description to assist identifying common mission phases, tasks/objectives, and subtasks/subobjectives. The printout contains the number and title/description, which are used to identify the commonalities; a blank column for recording the numbers of the common mission phases, tasks/objectives, and subtasks/subobjectives.

Form 3 is used for Steps 3.1 and 3.2 of the ETR analysis. This form is a printout of information contained in the DBMS database, with blank columns for data elements generated in these steps, which are to be entered into the database. The printout is indexed on the number data element, to present a hierarchial list. The printout should be limited to the initial occurrence of each element to prevent analyzing common mission phases, tasks/objectives, subtasks/subobjectives repeatedly. The printout contains the number, title/description, crew positions, and the initials of the developer of the task/objective. If the current analyst is different from the original developer, the analyst's initials can be recorded in the developer column, separated from the original developer's initials by a comma or slash. Blank columns for criticality codes (H, M, L) and objective classification codes (1, 2, 3, 4, 5, 6) are used to record the codes for each task/objective based on the determinations of the analyst.

Form 4 is used for Step 2.2 of the ETR analysis. This form is a printout of information contained in the DBMS database, with blank columns for data elements generated in this step, which are to be entered into the database. The printout is indexed on the number data element to present a hierarchial list. The printout should be limited to the initial occurrence of each element to prevent analyzing common mission phases, tasks/objectives, subtasks/subobjectives repeatedly. The printout contains the number, title/description, crew positions, and conditions of performance. A blank column for standards of performance is used to record the standards determined by the analyst for each mission phase, task/objective, and subtask/subobjective.

Form 5 is used for Step 3.5 of the ETR analysis. This is a printout of information contained in the database, with blank columns for data elements generated in this step, which are to be entered into the database. The printout is indexed on the number data element to present a hierarchial list. The printout should be limited to the initial occurrence of each element to prevent analyzing common mission phases, tasks/objective, and subtasks/subobjectives repeatedly. The printout contains the number, title/description, crew positions, conditions of performance, standards of performance, criticality codes, perishability results, and ET nomination results. A blank column for ET implementation codes (i.e., I, S, O ,Q, H, T, and X) is used to

record the codes determined by the analyst for each mission phase, task/objective, subtask/subobjective.

Form 6 is used for Step 3.6 of the ETR analysis. This is a printout of information contained in the database. This printout is used to validate the database contents. The printout is indexed on the number data element to present a hierarchial list. The printout should be limited to the initial occurrence of each element to prevent valiging common mission phases, tasks/objectives, and subtasks/subobjective repeatedly. The printout contains the number, title/description, crew positions, criticality codes, objective classification codes, perishability results, ET nomination results, and ET feasibility codes.

No forms are possible for Steps 1.1, 1.2, 1.9, 3.3, or 3.4, since these steps are either to be done by the DBMS software or are off-line tasks. The exception to this is Step 1.9 because it is envisioned that direct input into the database should be feasible.

Page No.: _____

DATA ENTRY FORM 1

NUMBER	TITLE/DESCRIPTION	CONDITIONS	POSITION	AUDIT TRAIL INFORMATION
				Source:
				Page No.:
				Developer:
				Mil. Task No.:
				Source:
				Page No.:
				Developer:
				Mil. Task No.:
				Source:
				Page No.:
				Developer:
				Mil. Task No.:
				Source:
				Page No.:
				Developer:
				Mil. Task No.:
				Source:
				Page No.:
				Developer:
				Mil. Task No.:
				Source:
				Page No.:
				Developer:
				Mil. Task No.:

Page No.: _____

PRINTOUT FORM 2

NUMBER	DESCRIPTION	FIRST	COMMON NUMBERS
(SIZE OF NUMBER DATA ELEMENT)	(50 CHARACTERS WIDE, MINIMUM; INDEX ON THIS DATA ELEMENT)	(INPUT TRUE/ FALSE)	(INPUT LIST FOR EACH TASK/ OBJECTIVE)

Page No.: _____

PRINTOUT FORM 3

NUMBER	TITLE/DESCRIPTION	POSITION(s)	DEVELOPER	CR	OBJ CAT
(SIZE OF NUMBER DATA ELEMENT; INDEX ON THIS DATA ELEMENT)	(50 CHARACTERS WIDE, MINIMUM)	(PRINTOUT LIST OF EACH POSITION PERFORMING EACH TASK; SIZE AS NEEDED)	(PRINTOUT INITIALS ENTERED FROM FORM NO. 1; SIZE AS NEEDED; ENTER NEW INITIALS AS NEEDED)	I N P U T C O D E	I N P U T C O D E

Page No.: _____

PRINTOUT FORM 4

NUMBER	TITLE/DESCRIPTION	POSITION(s)	CONDITIONS	STANDARDS
(SIZE OF NUMBER DATA ELEMENT; INDEX ON THIS DATA ELEMENT)	(50 CHARACTERS WIDE, MINIMUM)	(PRINTOUT EACH POSITION PERFORMING EACH TASK; SIZE AS NEEDED)	(PRINTOUT LIST OF CONDITIONS FOR EACH TASK/ OBJECTIVE; SIZE AS NEEDED)	(INPUT STANDARDS FOR EACH TASK/ OBJECTIVE)

Page No.: _____

PRINTOUT FORM 5

NUMBER	TITLE/DESCRIPTION	POSITION(s)	CONDITIONS	STANDARDS	CR	PR	ET NOM	ET IMP
(SIZE OF NUMBER DATA ELEMENT; INDEX ON THIS DATA ELEMENT)	(50 CHARACTERS WIDE, MINIMUM)	(PRINTOUT LIST OF EACH POSITION PERFORMING EACH TASK; SIZE AS NEEDED)	(PRINTOUT LIST OF CONDITIONS FOR EACH TASK/ OBJECTIVE; SIZE AS NEEDED)	(PRINTOUT STANDARDS FOR EACH TASK/ OBJECTIVE)	PRINTOUT CODE	PRINTOUT RESULT	PRINTOUT RESULT	INPUT CODE

Page No.: _____

PRINTOUT FORM 6

NUMBER	TITLE/DESCRIPTION	POSITION(s)	CR	OBJ CAT	PR	IMPL	ET
(SIZE OF NUMBER DATA ELEMENT; INDEX ON THIS DATA ELEMENT)	(50 CHARACTERS WIDE, MINIMUM)	(PRINTOUT EACH POSITION PERFORMING EACH TASK; SIZE AS NEEDED)	PRINTOUT CODE	PRINTOUT CODE	PRINTOUT RESULT	PRINTOUT CODE	PRINTOUT RESULT

APPENDIX D

LIST OF ACRONYMS AND ABBREVIATIONS

AMC	U.S. Army Materiel Command
ARI	U.S. Army Research Institute for the Behavioral and Social Sciences
ARTEP, ARTEPs	Army Training and Evaluation Plan(s)/Program
ASA	Applied Science Associates, Inc.
ASAP	Army Streamlined Acquisition Process
C3I	Command, Control, Communications, and Intelligence
DBMS, DBMSs	Database Management System(s)
DCD	Directorates of Combat Development
DOTD	Directorates of Training and Doctrine
ECA	A specific Early Comparability Analysis technique
ET	Embedded Training
ETR, ETRs	Embedded Training Requirement(s)
FEA	Front-End Analysis
FM, FMs	Field Manual(s)
FOG-M	Fiber-Optic Guided Missile
FSED	Full-Scale Engineering Development
HARDMAN	HARDware versus MANpower analyses
HFE	Human Factors Engineering
IR&D	Internal Research and Development
ISD	Instructional Systems Development
JMSNS	Justification for Major System New Start
LCSMM	Life Cycle Systems Management Model
LSAR	Logistic Support Analysis Record(s)
MAA	Mission Area Analysis
MANPRINT	MANpower and PeRsonnel INTegration

MOS	Military Occupational Specialty(ies)
OJT	On-the-Job Training
O&O	Organizational and Operational
PMCS	Preventive Maintenance Checks and Services
PM TRADE	U.S. Army Project Manager for Training Devices
POI	Program of Instruction
ROC	Required Operational Capability
SM, SMs	Soldier's Manual(s)
SME, SMEs	Subject Matter Expert(s)
SMMP	System MANPRINT Management Plan
SOP	Standard Operating Procedures
SSG	Special Study Group
SSI	Soldier-System Interface
STF	Special Task Force
STRAP	System Training Plan
TM, TMs	Technical Manual(s)
TRADOC	U.S. Army Training and Doctrine Command
TROC	Tentative Required Operational Capability
TSM, TSMs	TRADOC System Manager(s)
VDU	Visual Display Unit